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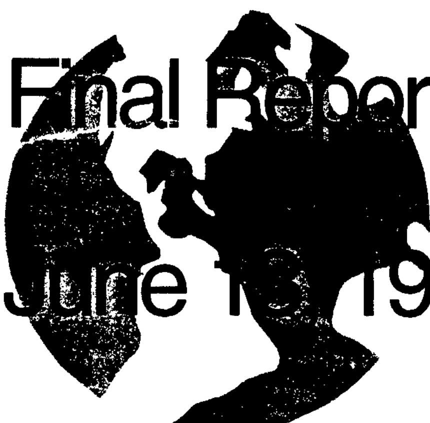
Automated Conversion of Troubleshooting Information



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13. ABSTRACT (Maximum 200 words)

The conversion of troubleshooting information is a formidable problem for the Navy and the DoD. The work described in this final report provides some insight into possible technologies and their contributions to a conversion system. The main objective of the ACT I project is to identify technologies that can be utilized as conversion resources, when developing a prototype system for converting troubleshooting information. The report details ways in which, existing and ManTech developed, algorithms can be configured to form a conversion system capable of converting graphic and test-based troubleshooting information.

Through survey results, ManTech identified the need to identify troubleshooting information in a number of formats. Predominate formats within the survey are tables and flow diagrams. The approach to identification of these tables and flow diagrams requires multifaceted algorithms that can provide robustness across a large population of data. The approach taken is to break the tables and flow diagrams into their fundamental components. For example, a table contains textual elements and graphical elements, in addition to the spatial information. The text items are produced as results of the OCR processing while spatial information is utilized to future define the layout of the information and to determine various relationships within the table flow diagram.

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1.0 EXECUTIVE SUMMARY

ManTech has been involved with image processing research since 1992, focusing on legacy data conversion issues. Our previous work has benefited this effort, allowing the team unique insight in problems faced by this project. ManTech utilizes a process that allows for a fertile research environment while maximizing effort toward individual research areas. The process consists of identifying small areas of research within the larger project, and forming research teams to address these pockets. Typically, a single pocket of research will be studied by two or more teams, allowing multiple approaches for a given solution. These multiple solutions build a layer of redundancy into the system providing robust performance. This approach has produced several algorithms to be identified and evaluated in a relativity short time span.

The conversion of troubleshooting information is a formidable problem, for the Navy and the Department of Defense (DoD). The work described within this final report provides some insight into possible technologies and their contributions to a conversion system. ManTech has been under contract with the West Virginia High Technology Consortium Foundation (WVHTCF), to research and develop algorithms that can be utilized to convert troubleshooting information for use within Interactive Electronic Technical Manuals (IETM). On May 22, 1997, ManTech demonstrated the initial results from Phase I and received an excellent review from the Navy representatives in attendance. This document provides a detailed description of the efforts performed to date in support of the Automated Conversion of Troubleshooting Information (ACTI) project.

This document consists of four major sections (Executive Summary, Phase I Project Objectives and Approach, Survey Findings, Technical Summary, and Appendixes A and B. The Phase I objectives and approach provide a brief description of the objectives and how they relate to the various areas documented in the technical summary. This section is provided to give the reader an overview of how the various areas of research relate and how the knowledge captured within the image data is represented within the MIL-D-87269 database.

The results of an initial survey are represented within Section 3.0. Details describing the various troubleshooting formats identified are clarified in detail. Section 4.0 provides the research findings and details algorithms developed under this effort. The various appendices support the survey findings and the technical summaries.

ManTech would like to thank the WVHTCF for their support throughout the ACTI project. Additionally, ManTech would like to thank the Office of Naval Research (ONR) and Naval Surface Warfare Center Carderock Division (NSWC-CD) for their efforts in supporting the ACTI project. ManTech would also like to thank the Naval Aviation Depot North Island (NADEPNI) for providing initial manual sets from which we based the majority of the survey findings.

2.0 PHASE I PROJECT OBJECTIVES AND APPROACH

Phase I consists of two major tasks: the discovery process, and researching processing and conversion issues. These tasks are discussed in detail in the "Research Finding" section of this report. This section provides a brief introduction to the objectives of the major task and a general approach to the development of algorithms supporting possible solutions.

2.1 Discovery Process

One of the difficulties associated with the conversion of paper-based troubleshooting information is that the troubleshooting data can appear in a variety of distinct functional and visual formats. Therefore, as a prelude to construction of processing algorithms, we conduct a discovery process (or survey) with the goal of identifying, quantitatively, the most common types of troubleshooting information within technical manuals. ManTech's approach to the survey was to examine several different manuals across a large number of programs and manufactures. From previous surveys conducted in previous projects, ManTech has found that the representation of information within a technical manual varies greatly. This variance in information representation within Technical Manuals (TM) drives the need for a comprehensive survey.

The ManTech survey consists of roughly 13,500 pages of examples. Programs that these manuals originated from are the F18, E-2C, RSTS, and S-3 programs. The F-18 program is supported by a number of different contractors. The prime contractor for the F/A-18 and the manufacturer of the forward fuselage and wings is McDonnell Douglas Aerospace of St. Louis, Missouri. The center and aft fuselage is built by Northrop Grumman Corporation of Los Angeles, California. The engines are made by General Electric Aircraft Engines of Lynn, Massachusetts, and the radar is manufactured by Hughes Aircraft Company of Los Angeles. The E-2C Hawkeye is the Navy's all-weather, carrier-based tactical warning and control system aircraft, supported by Grumman Aerospace Corp. The S-3 aircraft is used to hunt and destroy enemy submarines and provide surveillance of surface shipping. The ES-3 version is fitted for electronic warfare and reconnaissance; the prime contractor is Lockheed-California Company. These three systems encompass six different major manufacturers providing a good sampling of data.

ManTech found that the majority of troubleshooting information in these technical manuals was contained in tables. Other formats that were also prominent within these manuals were graphical and schematic information. Decision trees however represented approximately six percent of the surveyed data. This was less than initially thought and ManTech plans to survey additional manuals throughout the duration of this work.

2.2 Research Areas of Processing and Conversion

ManTech utilized an approach that has proven successful in past research and development efforts to accomplish the objectives of the ACTI project. The main objective of the ACTI project is to identify technologies that can be utilized as conversion resources, when developing a prototype system for converting troubleshooting information. The following subsections are a

brief description of how the existing and ManTech developed algorithms can be configured to form a conversion system capable of converting troubleshooting information.

The first issue that must be addressed in conversion is a system's ability to delineate between purely textual items and graphical items. Troubleshooting information often utilizes both textual and graphical information in combination to convey related information. The ability to delineate between textual items and graphical items is hence highly desirable when converting troubleshooting information. As found in the past, commercial products are focused on the separation of text from an image of a standard printed page. These market pressures do not lend themselves to the unique realm of troubleshooting information. Thus, ManTech must provide a better approach to separation in order to provide a viable prototype. The text separation information (in Section 4.0) of this document provides a detailed description of the effort.

Past recognition projects have indicated that a large percentage of the operator's time is spent verifying that the text is correct. As much as 50% of the total touch time thus cost, in past efforts have been involved with text validation. To compound this problem, OCR engines are not designed for random page layouts. The market of OCR engines is centered on pages that are of standard row column orientation; thus, the engines are tuned for maximum performance in these instances. This tuning of the recognition engine provided an opposite effect as the image varied from this standard layout. Thus, the need to identify an OCR tool that will minimize the operator's text QA burden in a prototype system had to be addressed in this initial phase. A detailed description of the process and criteria for the OCR engine selection is stated in Section 4.0 of this document.

Through the survey results, ManTech identified the need to identify troubleshooting information in a number of formats. Predominate formats within the survey are tables and flow diagrams. The approach to identification of these tables and flow diagrams requires multifaceted algorithms that can provided robustness across a large population of data. The approach taken is to break the tables and flow diagrams down into their fundamental components. For example, a table consists of textual elements and graphical elements, in addition to the spatial information that relates the various textual and graphical items. Section 4.0 describes various approaches to this task. The recognition of the graphical element from within the vector space is discussed within Sections 4.3 and 4.4. The text items are produced as a result of the OCR processing described in Section 4.2. The spatial information is utilized to future define the layout of the information and to determine various relationships within the table of flow diagram. This spatial information processing is described in Section 4.5.

The usability IETM data is often defined by its support hype links between related items within the IETM data. Linkages can span all types of data (textual, graphical, IPB, etc.,). A conversion system must be able to capture this information across all types of data. These linkages can be either explicate or implicates; the identification of these linkages is discussed in Sections 4.6 through 4.9. These sections detail the use of natural language processing techniques as they apply to the conversion of troubleshooting information.

At the heart of IETM conversion systems sits a MIL-D-87269 database implementation. From past work with this military standard it has been apparent that there are inherent problems due to the lack of specificity or loose specifications. This is not new to ManTech and our solution is to develop an export capability for the predominate tools available today. ManTech has elected to support export capabilities to both Advanced Integrated Maintenance Support System (AIMSS) and the existing Graphics Conversion System (GCS) technologies. A complete description of our MIL-D-87269 implementation is detailed within Section 4.12 "Database Advancements."

Some general utilities have been developed to support this effort. A description of these are included, with details describing their possible usage in a prototype conversion system and its various components.

3.0 SURVEY FINDINGS

A survey was conducted of all technical manuals provided by Naval Aviation Depot North Island. This manual set included 35 manuals from the F18, E-2C, RSTS, and ES-3 programs, containing over 13,500 pages of troubleshooting information.

This survey however, should not be considered complete. The survey was heavily weighted toward data contained within the F18 manuals, as 24 of the 35 manuals provided by NADEPNI were F18 manuals. We expected to receive at least 106 additional manuals, but at present, these manuals have not yet arrived.

We used the survey as a tool to gain a comprehensive understanding of the information contained within troubleshooting manuals. We were able to categorize types of information into common groups and identify which areas to target in order to gain the maximum benefit from the initial research and development efforts.

The initial results to the survey are shown in Table 3.0-1 with examples of each survey category given in Appendix A.

Table 3.0-1 Survey Results

P/N/R = PROCEDURE/NORMAL INDICATION/REMEDY
P/N/R/G = PROCEDURE/NORMAL INDICATION/REMEDY WITH EMBEDDED GRAPHICS
P/N/Y = PROCEDURE/NO/YES
P/F/A = PROCEDURE/FAULT/ACTION
S/P/R = STEP/PROCEDURE/RESULT
S/P/R/G = STEP/PROCEDURE/RESULT WITH EMBEDDED GRAPHIC
DT = DECISION TREE
DT/T = DECISION TREE WITH CORRESPONDING TABLE
MC/FC = MAINTENANCE CODE/FAILURE CODE
TXT (p) = TEXT IN PARAGRAPH FORM
TXT (o) = TEXT IN OUTLINE FORM
GRPH = GENERAL GRAPHIC
PDD = POWER DISTRIBUTION DIAGRAM
FBD = FUNCTIONAL BLOCK DIAGRAM
FID = FAULT ISOLATION DIAGRAM
SCH = SCHEMATIC
NOMEN = NOMENCLATURE
SETUP = TEST SETUP INFORMATION

	TROUBLESHOOTING																			
Manual	P/N/R	P/N/R/G	P/N/Y	P/F/A	S/P/R	S/P/R/G	DT	DT/T	MC/FC	TXT (p)	TXT (o)	GRPH	TBL	PDD	FBD	FID	SCH	NOMEN	SETUP	TOTAL
A1-F18AE-580-200	7	0	55	0	0	0	0	0	2	0	0	22	0	0	0	0	0	2	0	88
A1-F18AH-742-200	42	0	73	0	0	0	0	0	42	0	0	45	0	0	0	0	0	3	0	205
A1-F18AE-740-200	76	0	485	0	0	0	0	0	17	0	0	115	0	0	0	0	0	10	19	722
A1-F18AH-740-220	66	0	688	0	0	0	0	0	65	0	0	21	0	0	0	0	0	0	0	840
A1-F18AE-460-210	25	0	149	0	0	0	0	0	0	0	0	46	0	0	0	0	0	10	0	230
A1-F18AE-740-230	82	0	561	0	0	0	0	0	78	0	0	44	0	0	0	0	0	1	0	766
A1-F18AC-570-220	98	0	680	0	0	0	0	0	0	0	0	64	0	0	0	0	0	0	0	842
01-S3AAA-2-3.13	0	0	0	0	9	19	110	0	0	15	54	67	11	11	43	1	0	35	0	375
01-E2AAA-2-17.7	0	0	0	0	256	0	86	0	8	35	211	193	27	2	20	0	5	25	0	868
01-E2AAA-2-15.7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	363	0	0	0	0	363
A1-F18AC-130-200	81	18	399	0	0	0	0	0	0	0	0	96	0	0	0	0	0	13	131	738
A1-F18AC-240-200	11	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	50
A1-F18AC-410-200	72	0	61	0	0	0	0	0	0	0	0	29	0	0	0	0	0	2	11	175
A1-F18AC-420-200	36	0	178	0	0	0	0	0	0	0	0	33	0	0	0	0	0	13	41	301
A1-F18AC-440-200	37	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	41
A1-F18AC-450-200	34	0	48	0	0	0	2	0	0	0	0	7	0	0	0	0	0	2	13	106
A1-F18AC-460-200	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
A1-F18AC-510-200	28	0	24	0	0	0	0	0	0	0	0	7	0	0	0	0	0	5	8	72
A1-F18AC-744-210	0	0	102	16	0	0	0	0	0	0	0	8	52	0	0	0	0	0	0	178
A1-F18AE-760-200	128	0	429	0	0	0	0	0	48	0	0	98	0	0	0	0	0	11	187	901
A1-F18AH-740-230	61	0	554	0	0	0	0	0	83	0	0	31	0	0	0	0	0	1	125	855
01-E2AAA-2.17.8.1	0	0	0	244	0	0	0	0	101	0	0	16	20	0	3	0	0	0	23	407
01-E2AAA-2.17.8.2	0	0	0	289	0	0	0	0	22	0	0	19	0	0	0	0	0	0	26	356
01-S3AAA-2-3.2	0	0	24	0	0	0	44	0	0	0	25	14	15	0	0	0	6	15	0	143
01-S3B-2-3.11	0	0	27	0	0	0	211	0	0	0	26	34	5	0	46	0	17	25	0	391
16-30APM446-2	0	0	0	0	0	0	96	0	0	16	0	1	0	0	11	0	6	5	0	135
01-ES3AAA-2-3-14.1	0	0	0	0	0	0	0	0	0	77	107	72	364	0	10	0	292	57	0	979
A1-F18AH-710-200	3	0	17	0	0	0	0	0	2	0	0	10	0	0	0	0	0	1	0	33
A1-F18AE-460-200	30	0	159	0	0	0	0	0	19	0	0	81	0	0	0	0	0	20	0	309
A1-F18AC-770-200	50	0	145	0	0	0	0	0	0	0	0	45	0	0	0	0	0	15	0	255
A1-F18AC-750-200	43	0	16	0	0	0	0	0	2	0	0	25	0	0	0	0	0	7	0	93
A1-F18AE-740-230	79	0	300	0	0	0	0	0	51	0	0	29	0	0	0	0	0	2	0	461
A1-F18AC-270-200	127	0	0	0	0	0	0	164	12	0	0	71	38	0	0	0	0	19	0	431
01-E2AAA-2-16.3	0	0	0	0	0	0	0	0	1	0	189	35	98	0	40	0	0	43	0	406
01-E2AAA-2-15.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	400
TOTAL	1216	18	5204	549	265	19	549	164	553	143	612	1382	630	13	936	1	326	342	596	13518

In Table 3.0-1, the categories P/N/R, P/N/R/G, P/N/Y, P/F/A, S/P/R, S/P/R/G, MC/FC, and TBL were all categories of troubleshooting information contained in a table form of one kind or another. (See Appendix A.) This accounted for 8,454, or 62.5% of the troubleshooting information surveyed. Of course, nearly all of the procedural information presented in the troubleshooting manuals was in text form, whether it was text contained within a table, decision tree, or text in paragraph or outline form. So, using the information gained from the survey we identified a need to focus on a few defined areas such as text segmentation, text recognition, table recognition, flow diagram recognition, and of course, implementing an 87269 compliant database in order to store all of the extracted information.

4.0 TECHNICAL SUMMARY

The following sections detail research efforts in support of the ACTI project.

4.1 Text Separation

Generating accurate results from the Optical Character Recognition (OCR) engine is an essential component in creating a usable conversion system. Currently the OCR technology performs adequately when given a full page of text without graphics to confuse it; however, with a large amount of graphical objects on the page the performance drops dramatically. OCR engines are tuned to perform well on full text pages, which represents a majority of the pages processed by their users. However, technical manuals have many pages containing graphical objects. These objects include, flow diagrams, line art, table grids, revision symbols and more. In order to process technical manuals properly a method of increasing the accuracy of the OCR when confronted with graphics is needed.

The approach taken to solve this problem was to perform preprocessing of the image before sending it to the OCR engine. The purpose of preprocessing is to separate the graphical objects from the text objects. The objective is to eliminate the graphical objects while retaining 100% of the text objects. Currently, Blob Analysis is the method used to perform this preprocessing.

Obviously, there has not been a system developed to date that will separate text and graphics with 100% accuracy. If this were the case, the OCR engines would incorporate it and see increased performance. The perfect separation of text and graphics is difficult because a small portion of the graphic objects have very similar characteristics to text objects and cannot easily be distinguished from the text objects. In order to eliminate these graphic objects, some of the text objects would also have to be removed from the candidate list. Over-classification is used to overcome this problem. The graphic objects that have text-like characteristics are not removed from the candidate list and the OCR engine is relied upon to remove these remaining objects.

Figure 4.1-1 shows an example flow diagram page from a technical manual. Figure 4.1-2 shows the results of performing the separation preprocessing on Figure 4.1-1. The top window pane shows what has been identified as text while the bottom pane shows what has been removed as a graphical object.

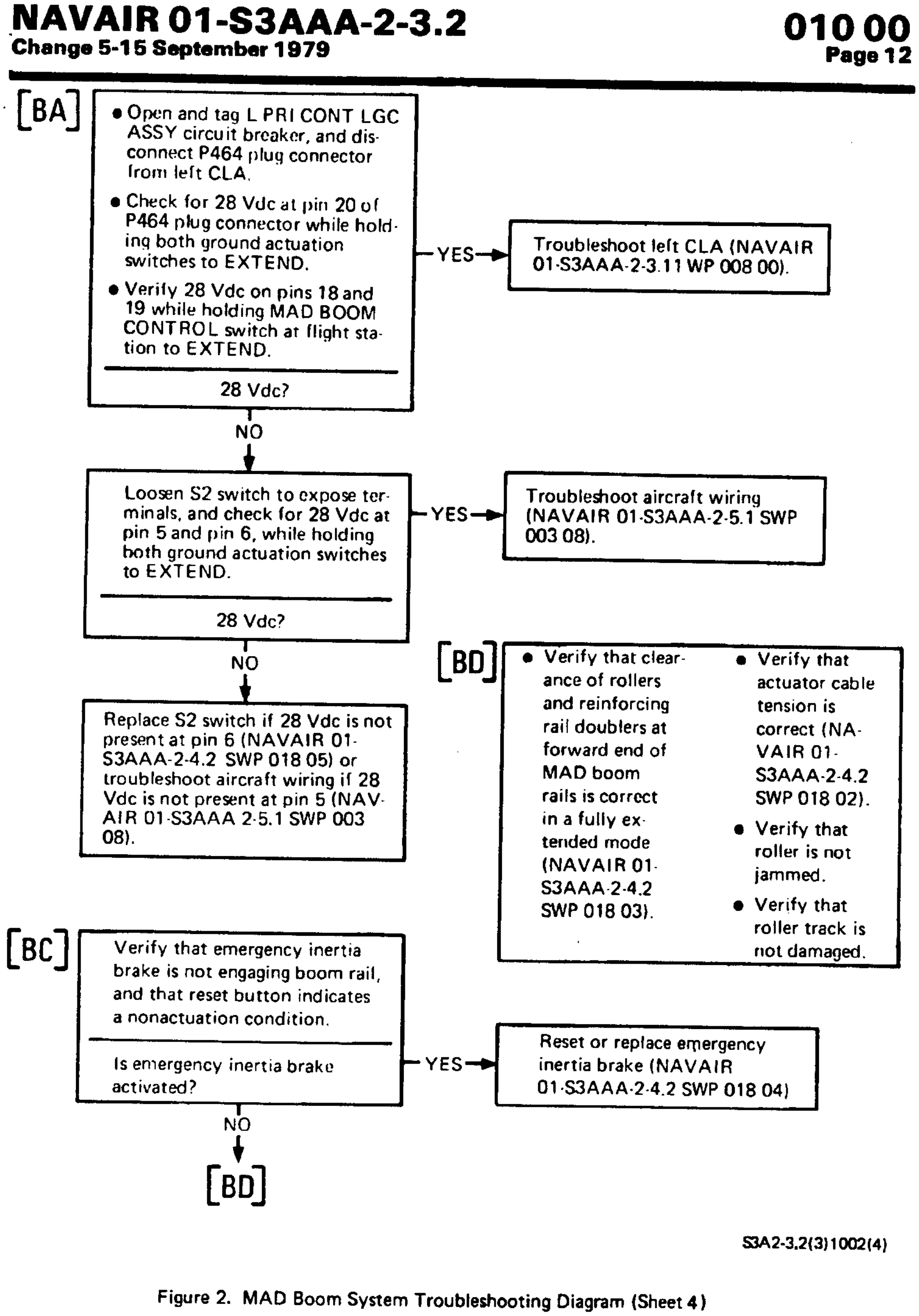


Figure 4.1-1 Example Flow Diagram Page

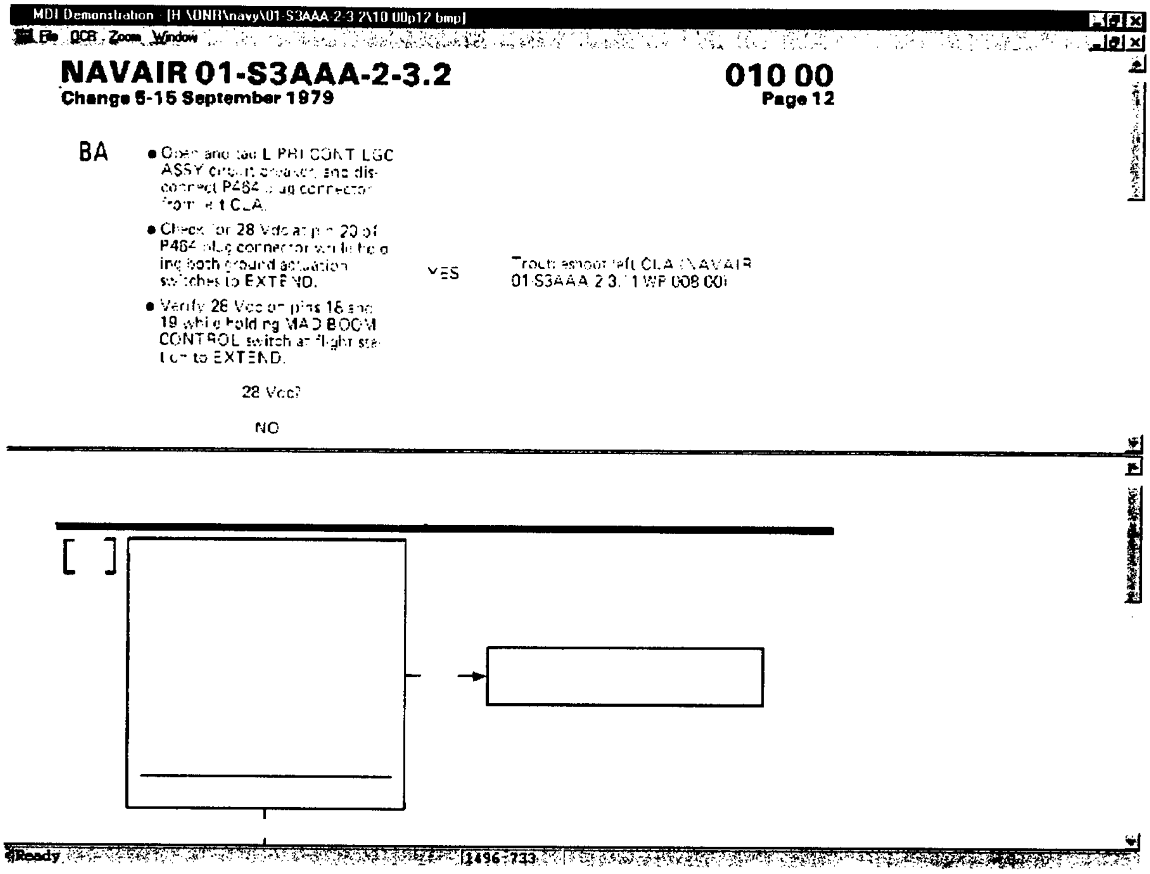


Figure 4.1-2 Flow Diagram After Text Separation

It is not enough to remove the graphics from the page and then send it to the OCR engine. If the entire page is processed "as is," the OCR engine still performs poorly. When the text on a page is placed randomly (not in perfect rows), the OCR engine attempts to align what is there into rows. This has the effect of moving the text to the wrong coordinates. In addition, text has been placed into two rows when it is aligned between what the OCR engine has identified as rows. This causes duplicate text when there was none on the original image. The OCR engine also performs poorly if each character of text is processed separately. It uses higher level relationships to improve the accuracy of the recognition process and these relationships are not available when a single character is processed.

A method of grouping the text into logical groupings was developed to overcome these problems. An attempt is made to group the text into rows, which eliminates the single character problem. There is no attempt made to group the text into rows across the entire image; only objects that are spatially close are grouped. Each bounded area is sent to the OCR engine separately for processing. This eliminates the tendency of the OCR engine to try to group text into incorrect rows. Figure 4.1-3 shows the results of this processing on the same image previously shown. Note the separate groupings for each block in the diagram.

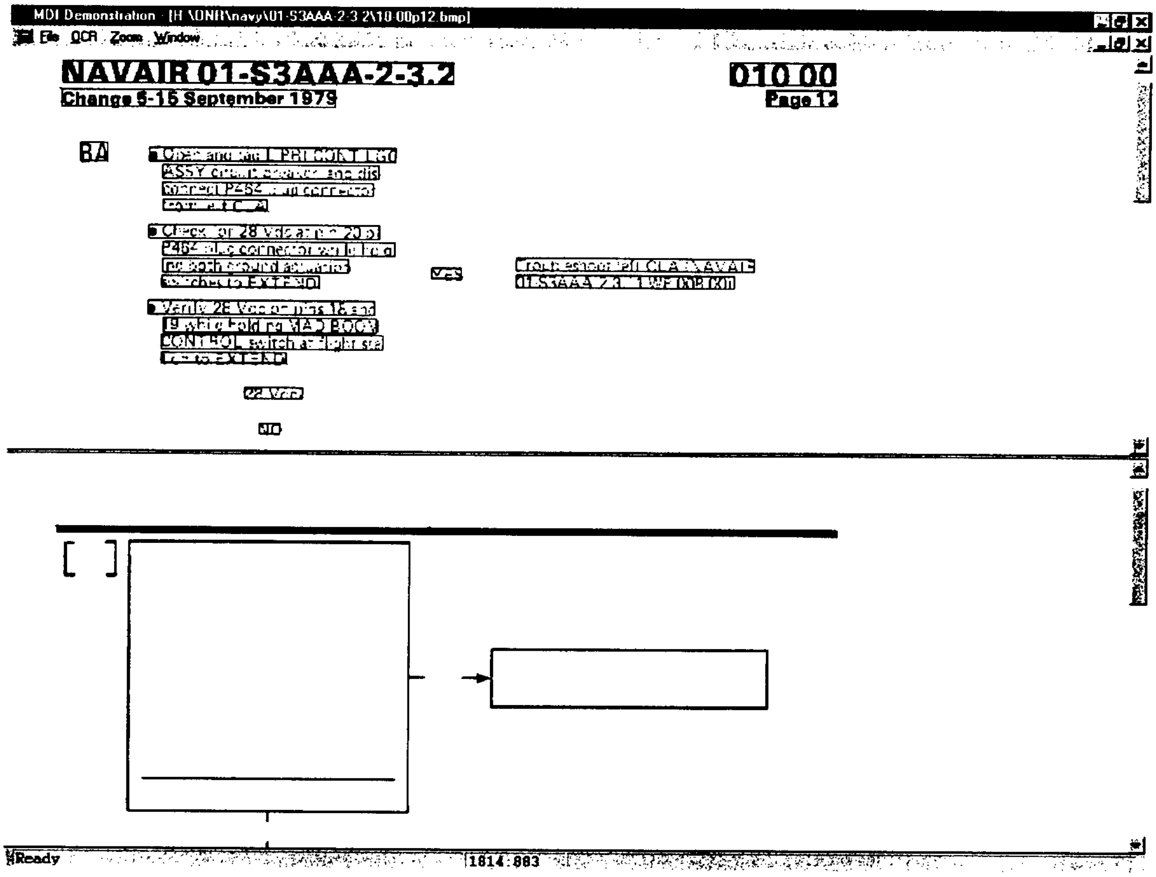


Figure 4.1-3 Flow Diagram After Text Grouping

As with any solution, there are problems under certain conditions. The use of Blob Analysis brings with it some characteristics that can affect the results of the preprocessing. If a piece of text is touching a piece of the graphic, such as a table grid or flow diagram frame, it will become part of that blob and not a separate one. This makes it indistinguishable from graphic objects. This problem usually occurs when the image has poor scan quality or, less frequently, it is because the text was printed on the page touching the object. Figure 4.1-4 shows an example image of a table with a surrounding grid. The scan quality is poor and a large percentage of the text is touching the grid. Figure 4.1-5 shows the results of separating the text and graphics. No solution to this problem has been found yet. This problem occurs seldom enough that the overall performance of the OCR engine is improved therefore it is desirable to use preprocessing.

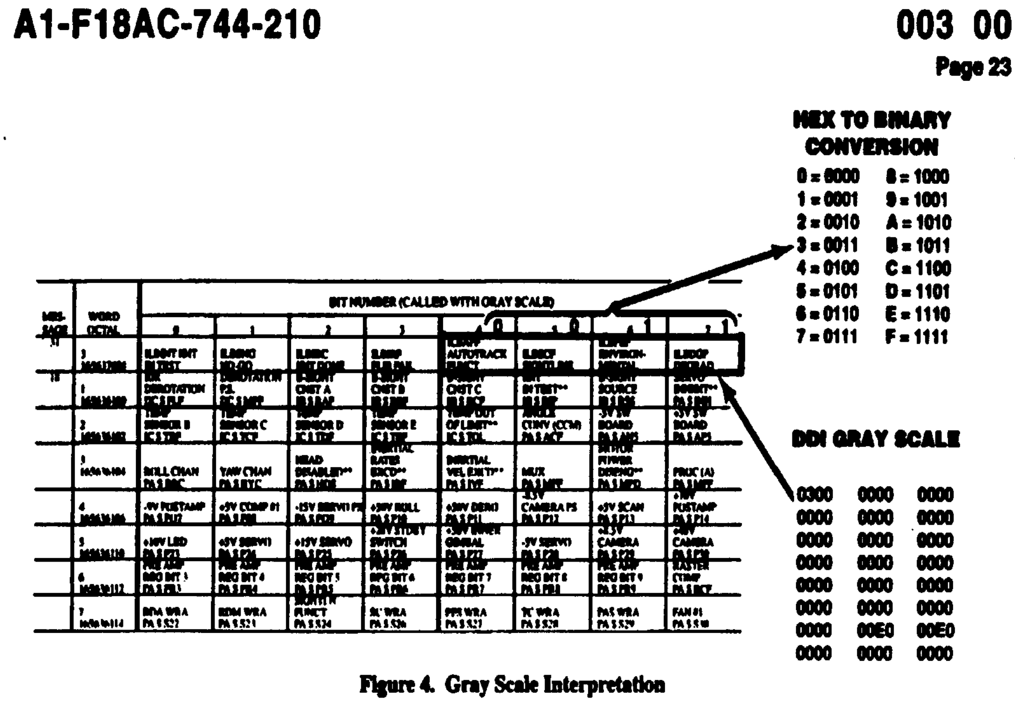


Figure 4.1-4 Example Table Which Produces Poor Separation

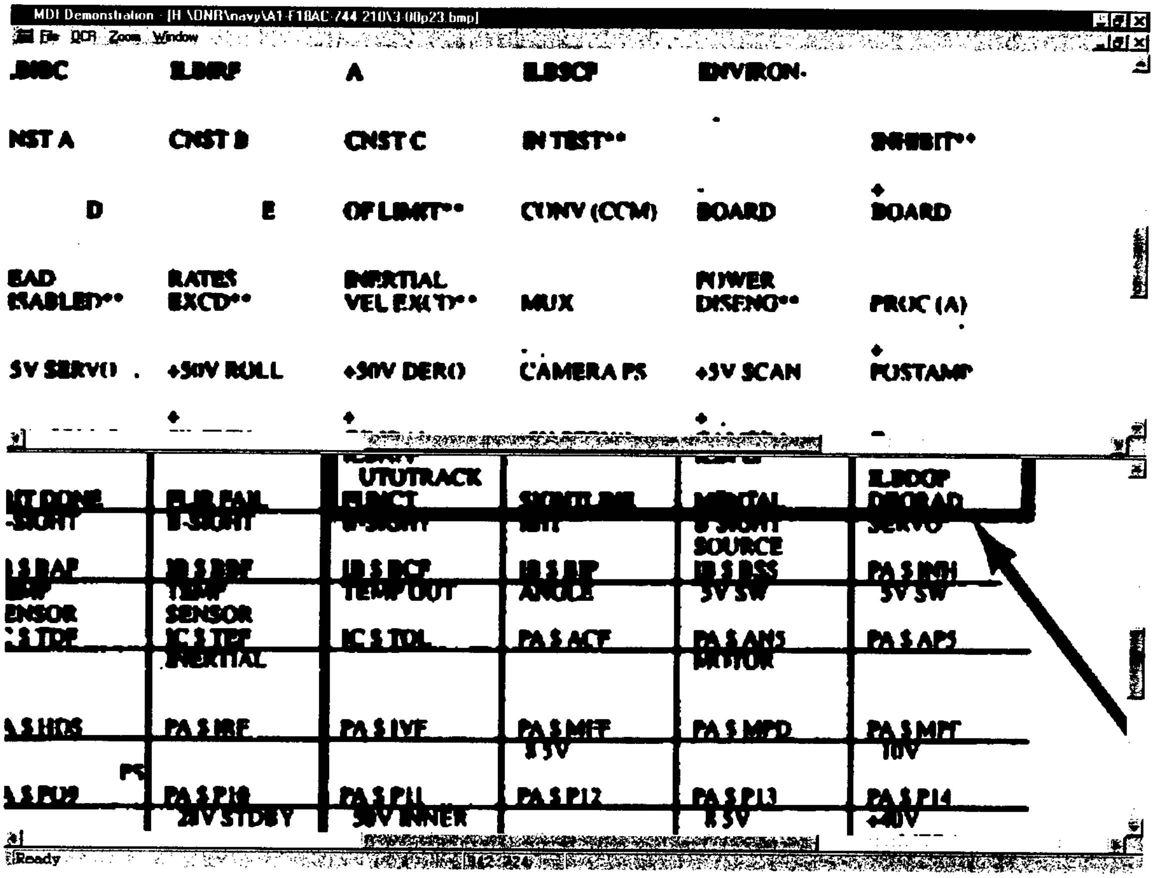


Figure 4.1-5 Results of Figure 4.1-4

4.1.1 Page Segmentation

In order to properly process pages, it must be determined what types of regions are on the page. For example, a page can consist of any combination of text, graphic, table, or flow diagram regions. Once each region is classified properly, processing can be performed using the method best suited to it. This can be done two ways: 1) have a user manually segment the image into proper regions or 2) attempt to perform some automated segmentation. It is preferable to require as little user intervention as possible to reduce the cost of the conversion process.

Research is being conducted to find methods of performing the automated segmentation. The method described here is one of many steps that will have to be performed to properly identify each of the regions. This first step attempts to separate the text regions from the others. There are two steps to this technique. The first step is to group the objects on the page into regions according to horizontal and vertical spacing. The second step is to classify a region as non-text if an object in the region has characteristics outside the normal for text.

This technique relies on the assumption that non-text regions will contain an object that has characteristics outside the normal for text. For example, a graphic usually contains at least one object that is much too large (too tall and too wide) to be a text object. This assumption holds true for the flow diagram boxes (which usually surround text) as well. If a table has borders around it, the border will also be outside the normal characteristic of text. If, however, a table is not framed by a border, this technique will classify it as text since it will only contain text in row-column format. Further processing will need to be conducted to properly classify these tables.

The following images demonstrate the results of this technique. The text regions are outlined in green, while the non-text regions are outlined in red.

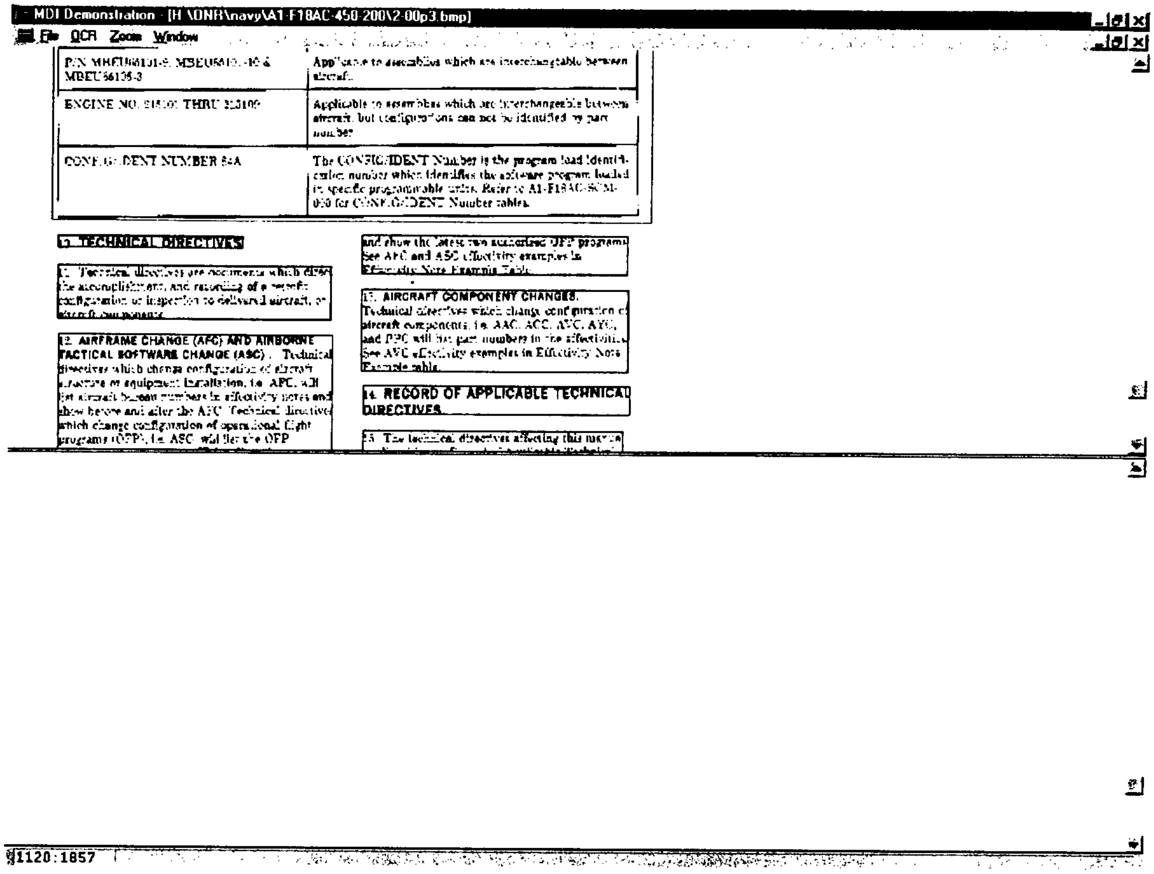


Figure 4.1.1-1 Text and Table with Grid

Effectivity Note Examples (Continued)

Effectivity Note	Definition
F/A-18C, F/A-18D 163434 THRU 163457	Applicable to all F/A-18C aircraft. Applicable to some bureau numbers of F/A-18D.
F/A-18D D-140 AND UP	Applicable to all F/A-18D aircraft after bureau number 164967.
160775 THRU 160785 BEFORE F/A-18 AFC 772	Applicable to F/A-18A and F/A-18B for bureau numbers listed, before modification by technical directive.
161213 AND UP; ALSO 160775 THRU 160785 AFTER F/A-18 AFC 772	Applicable to aircraft modified during production; also applicable when affected aircraft have been modified by technical directive.
160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-X IS INSTALLED	Applicable to F/A-18A and F/A-18B for bureau numbers listed if panel P/N XXXX-X is installed. (Configuration before AVC)
161213 AND UP; ALSO 160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-Y (AVC-102) IS INSTALLED	Applicable to aircraft modified during production; also applicable to aircraft components modified to the production configuration by technical directive. (Configuration after AVC)
P/N MBEU65101-9, MBEU65101-10 & MBEU65105-3	Applicable to assemblies which are interchangeable between aircraft.
ENGINE NO. 215101 THRU 215109	Applicable to assemblies which are interchangeable between aircraft, but configurations can not be identified by part number.
CONFIG/IDENT NUMBER 84A	The CONFIG/IDENT Number is the program load identification number which identifies the software program loaded in specific programmable units. Refer to A1-F18AC-SCM-000 for CONFIG/IDENT Number tables.

10. TECHNICAL DIRECTIVES.

11. Technical directives are documents which direct the accomplishment, and recording of a retrofit configuration or inspection to delivered aircraft, or aircraft components.

12. **AIRFRAME CHANGE (AFC) AND AIRBORNE TACTICAL SOFTWARE CHANGE (ASC).** Technical directives which change configuration of aircraft structure or equipment installation, i.e. AFC, will list aircraft bureau numbers in effectivity notes and show before and after the AFC. Technical directives which change configuration of operational flight programs (OFP), i.e. ASC, will list the OFP CONFIG/IDENT NUMBER in effectivity notes and show the latest two authorized OFP programs. See AFC and ASC effectivity examples in Effectivity Note Example Table.

13. **AIRCRAFT COMPONENT CHANGES.** Technical directives which change configuration of aircraft components, i.e. AAC, ACC, AVC, AYC, and PPC will list part numbers in the effectivities. See AVC effectivity examples in Effectivity Note Example table.

14. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

15. The technical directives affecting this manual are listed in the Record of Applicable Technical

Figure 4.1.1-2 Original Image Used for Figure 4.1.1-1

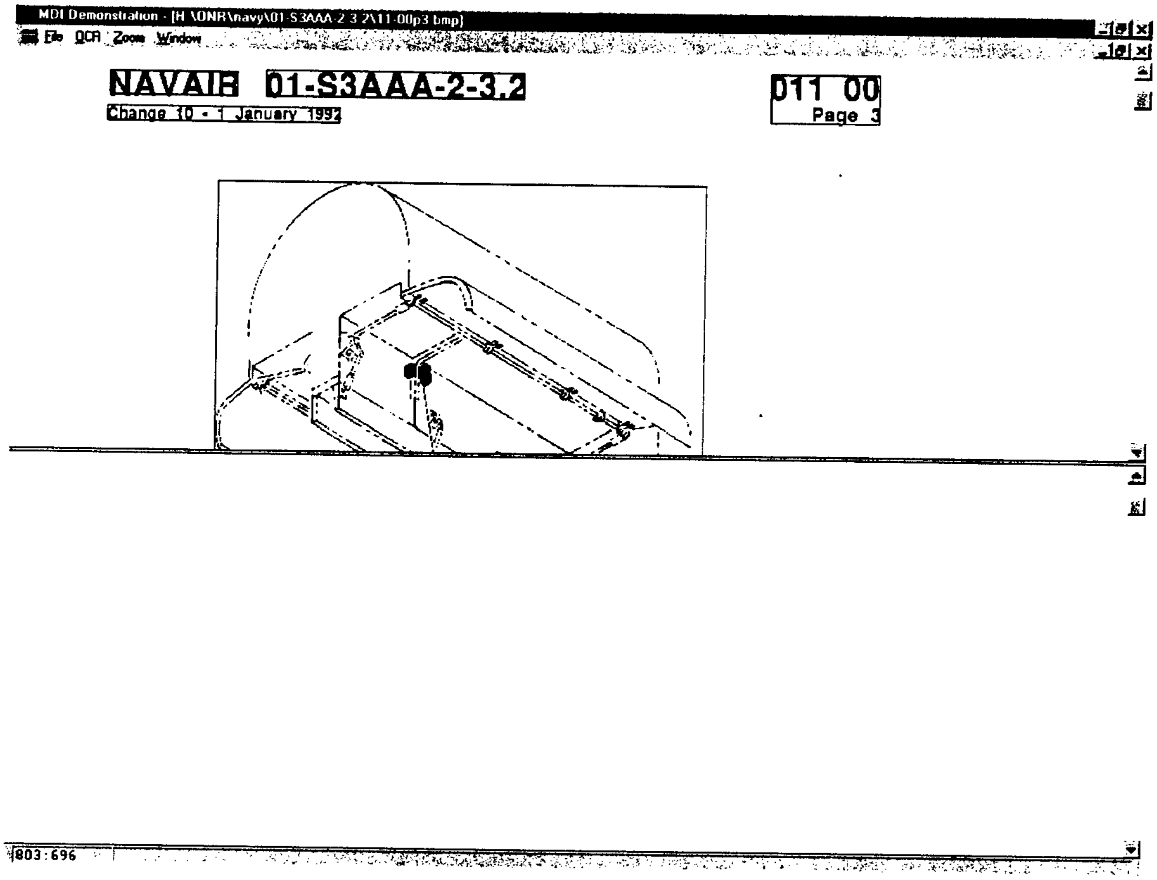


Figure 4.1.1-3 Graphic Region

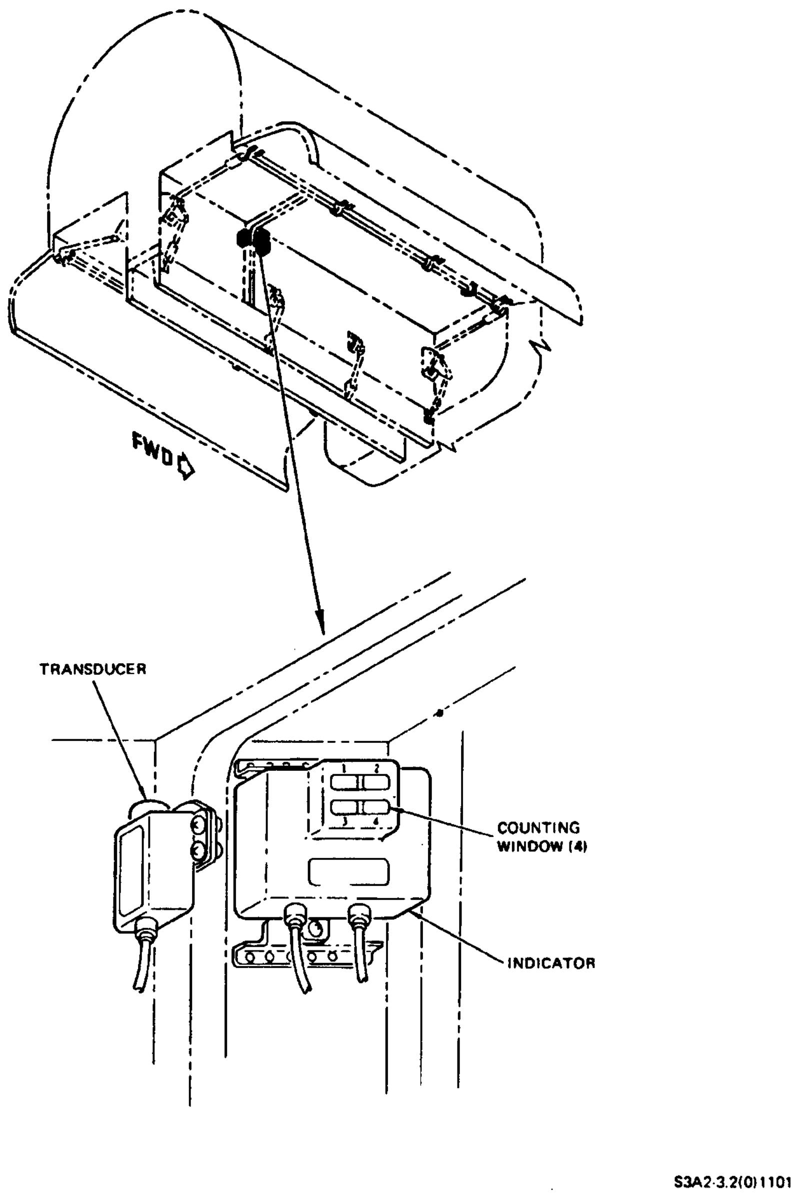


Figure 1. Counting Accelerometer Components Location Diagram (on Aircraft Not Modified by AFC-221)

Figure 4.1.1-4 Original Image Used for Figure 4.1.1-3

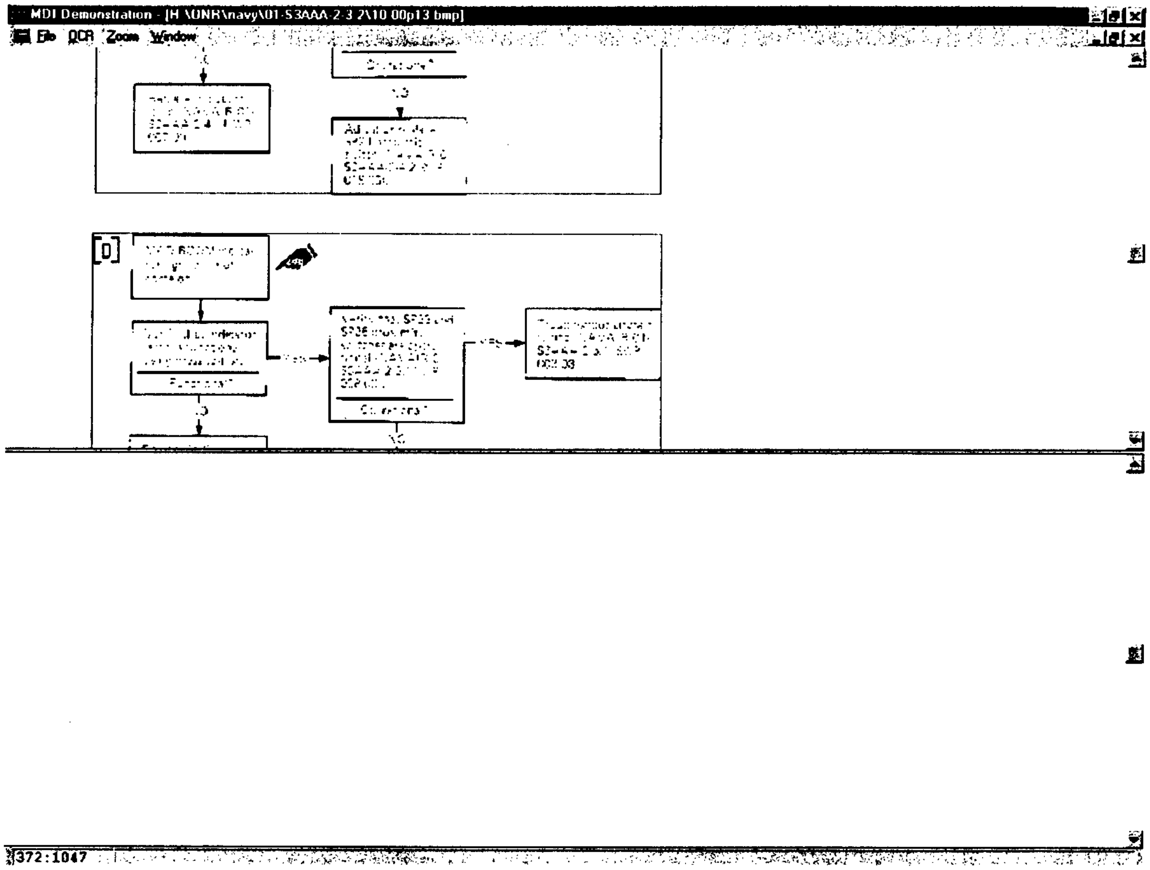


Figure 4.1.1-5 Flow Diagram Regions

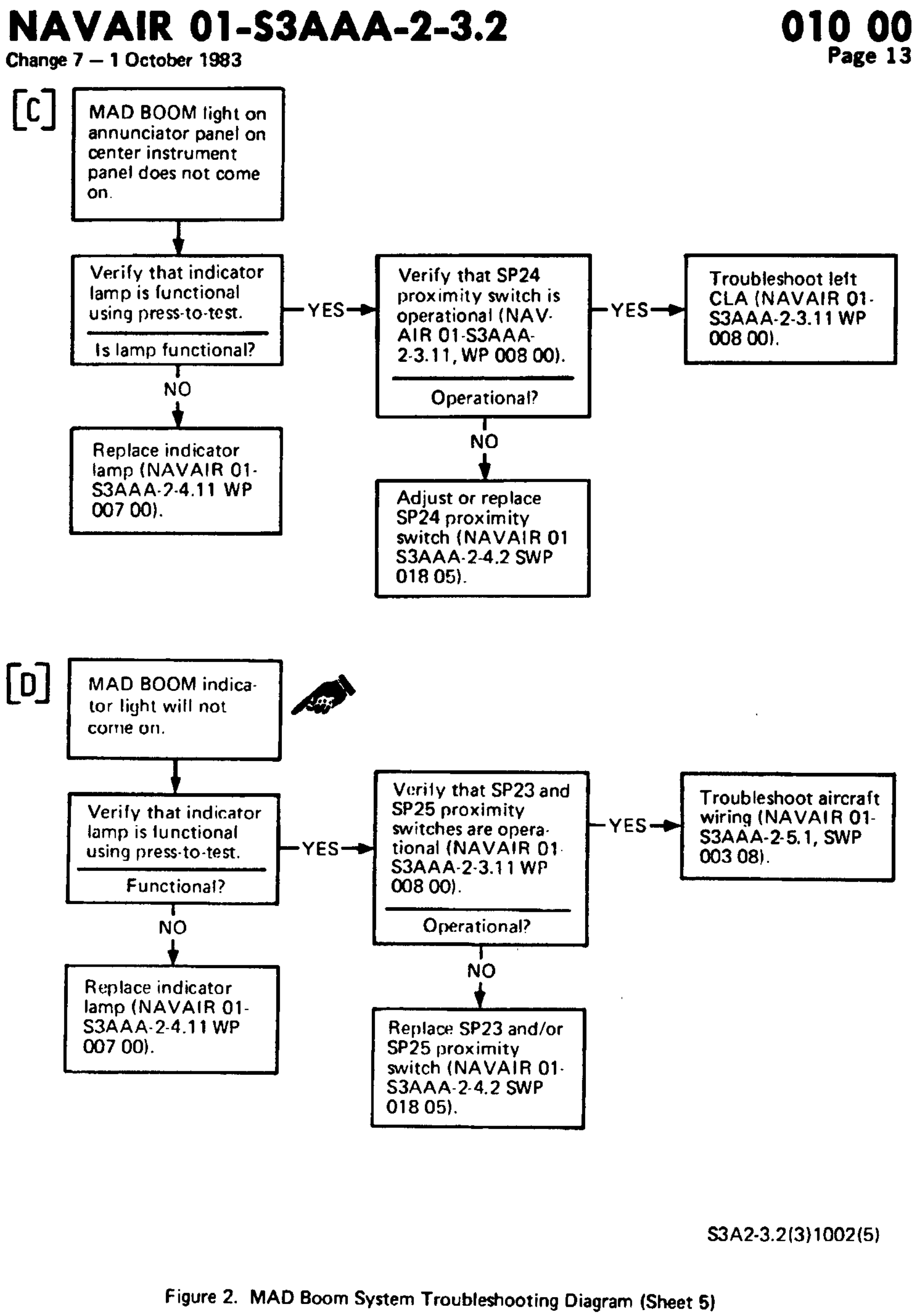


Figure 4.1.1-6 Original Image Used for Figure 4.1.1-5

The largest reason for incorrectly classified regions results from large "black bars" that are present in the image either from poor scanning indicating a change in a manual. Figure 4.1.1-7 shows an example of this. The only method of eliminating this problem is to identify the "black bars" and remove them before processing. Research will be conducted to do this in the future.

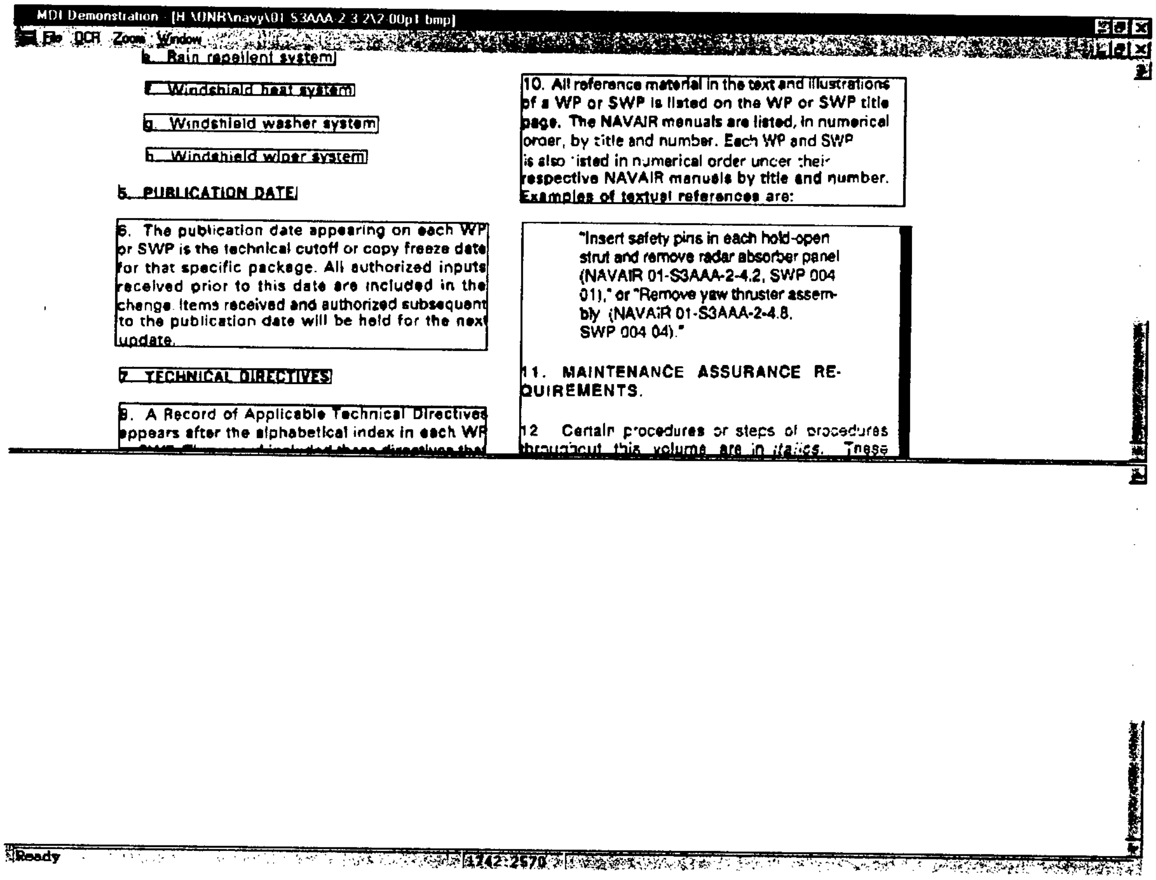


Figure 4.1.1-7 Example of Misclassified Text Region Due to Change Bar

NAVAIR 01-S3AAA-2-3.2
Change 8 - 15 July 1986

002 00
Page 1 of 2

INTRODUCTION

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

AIRFRAME GROUP SYSTEMS

1. **PURPOSE OF MANUAL.**

2. This manual contains testing and trouble shooting procedures for airframe group systems. The airframe group systems include the bomb bay doors system, infrared detection system, MAD boom system, windshield heat, windshield washer, windshield wiper, and rain repellent systems.

3. **END ITEMS COVERED IN THIS MANUAL.**

4. The end items and systems covered in this manual consist of the following:

a. Bomb bay doors and drive system.

b. Infrared detection system.

c. MAD boom system.

d. Counting accelerometer system.

e. Rain repellent system.

f. Windshield heat system.

g. Windshield washer system.

h. Windshield wiper system.

5. **PUBLICATION DATE.**

6. The publication date appearing on each WP or SWP is the technical cutoff or copy freeze date for that specific package. All authorized inputs received prior to this date are included in the change. Items received and authorized subsequent to the publication date will be held for the next update.

7. **TECHNICAL DIRECTIVES.**

8. A Record of Applicable Technical Directives appears after the alphabetical index in each WP or SWP. The record included these directives that affect equipment or procedures discussed in that package and provides the following information:

a. Type and number of Technical Directive. For example: AFC-30, AVC-1300. If the number has not been assigned, a dash will appear in this column.

b. The date of issue of the directive. If the directive has not been approved, a dash will appear in this column.

c. Title and ECP number.

d. The date the information was incorporated in the WP or SWP.

e. Technical Directives will be removed from the record at the next change or revision after rescission of the directive.

9. **METHOD OF REFERENCING.**

10. All reference material in the text and illustrations of a WP or SWP is listed on the WP or SWP title page. The NAVAIR manuals are listed, in numerical order, by title and number. Each WP and SWP is also listed in numerical order under their respective NAVAIR manuals by title and number. Examples of textual references are:

"Insert safety pins in each hold-open strut and remove radar absorber panel (NAVAIR 01-S3AAA-2-4.2, SWP 004 01)," or "Remove yaw thruster assembly (NAVAIR 01-S3AAA-2-4.8, SWP 004 04)."

11. **MAINTENANCE ASSURANCE REQUIREMENTS.**

12. Certain procedures or steps of procedures throughout this volume are in *italics*. These

Figure 4.1.1-8 Original Image For Figure 4.1.1-7

Initial indications from using this method show that it can be used as one of several steps needed to segment and identify different regions of an image.

4.2 Optical Character Recognition

To effectively implement character recognition capabilities into ACTI, it was imperative that we obtain a 32-bit OCR engine to replace our current version of OmniPage Pro 5. OmniPage Pro 5 was not 32-bit and was no longer supported by Caere. Upon acquisition of this engine, an interface needed to be developed to permit access to the engine's functionality, while being generic enough to allow for the possibility of changing the engine with minimal coding changes necessary. Once an interface was developed, it would then be necessary to apply domain specific knowledge to achieve the best possible results from the engine.

4.2.1 Benefits

The benefits of using a new OCR engine are twofold. First, a 32-bit engine provides significantly faster text recognition times than a 16-bit engine, thereby reducing the overall processing time. Second, the better recognition rates resulting from the newer technology will significantly speed up the text QA step and even possibly eliminate it (given we can achieve recognition results in the 99% range. This might be accomplished if we can identify and remove the entire graphic prior to text recognition).

4.2.2 Desired Features

It was decided that the engine that would best suit our needs would have the following features: pure 32-bit code, reasonable pricing, strong technical support, extremely flexible and easy to use Application Programming Interface (API), ability to handle gray-scale and color images, ability to find text at odd angles of rotation, high speed, and a high accuracy rate. Of all these features, no engine supported color images directly. These images could be indirectly handled by first converting the color to gray-scale. Similarly, no engine supported rotation at odd angles. The only way to handle this was by manually rotating the image to the desired degree.

After observing the tables and decision trees in the troubleshooting manuals, the position of text seems to be a very important issue. Our current engine provides no text position information as a result of processing. All of the engines to be evaluated provide this information. This information can be categorized into the following groups:

- Region Information - one or more lines of text with minimal vertical white space between them. This might be one cell of a table or one node in a decision tree.
- Line Information - one or more words of text all along the same horizontal axis.
- Word Information - one or more characters along the same horizontal axis with minimal horizontal white space between them. If the engine in use uses a dictionary, then there might be a confidence associated with this word or something to signify whether or not it was in the dictionary.
- Character Information - this would include a character confidence, point size, font type (Serif, San Serif, etc.), and any font characteristics (italics, bold, etc.).

All of the above would have bounding box coordinates. This information (in particular the region information) will greatly assist in the processing of the troubleshooting information by

providing a means to distinguish between problems and solutions (often located in different columns) and a way to navigate decision trees.

4.2.3 Initial Evaluation

For the initial evaluation, six OCR engines were evaluated using eight test images. The six engines were developed by the following companies: International Neural Machines (INM), Maxsoft-Ocron, ExperVision, Prime Recognition, Xerox, and Cognitive Technology. The eight test images consisted of one image from eight different manuals. This allowed the engines' performance to be measured over a wide range of manuals containing different font types. The graphics were removed from the images so they would not interfere with the testing of the accuracy of any of the engines. During the initial evaluation, text accuracy was the focal point. Once this had been determined, the top three engines were to be evaluated again on images containing both text and graphics. The results of the second evaluation would then be considered along with other important factors to finally decide which engine was to be purchased.

The evaluation process was straightforward. The images were zoned and pre-processed (despeckled, deskewed, etc.) if necessary, and then run through the OCR engine. Once through the recognition process, the hits, errors, and misses were recorded and a percentage was determined for each. A hit is a correctly identified piece of text. A miss occurs when there is a piece of text in the image that the engine doesn't see at all. An error occurs when the engine sees a piece of text in the image, but fails to recognize it correctly by either mistaking it for something else or identifying it as unrecognizable. Adding up the misses and errors for an image should give you a reasonable idea of how many edits would be required to ensure that all the text on a given image is correct. Since we wanted to minimize the number of edits per image, then clearly the engine that provided the lowest miss and error percentages would be the preferred engine.

The following eight images (Figures 4.2.3-1 through 4.2.3-8) were used in the initial evaluation process. Again, all of the graphics were removed from the test images in order to determine which engine had the best text accuracy.

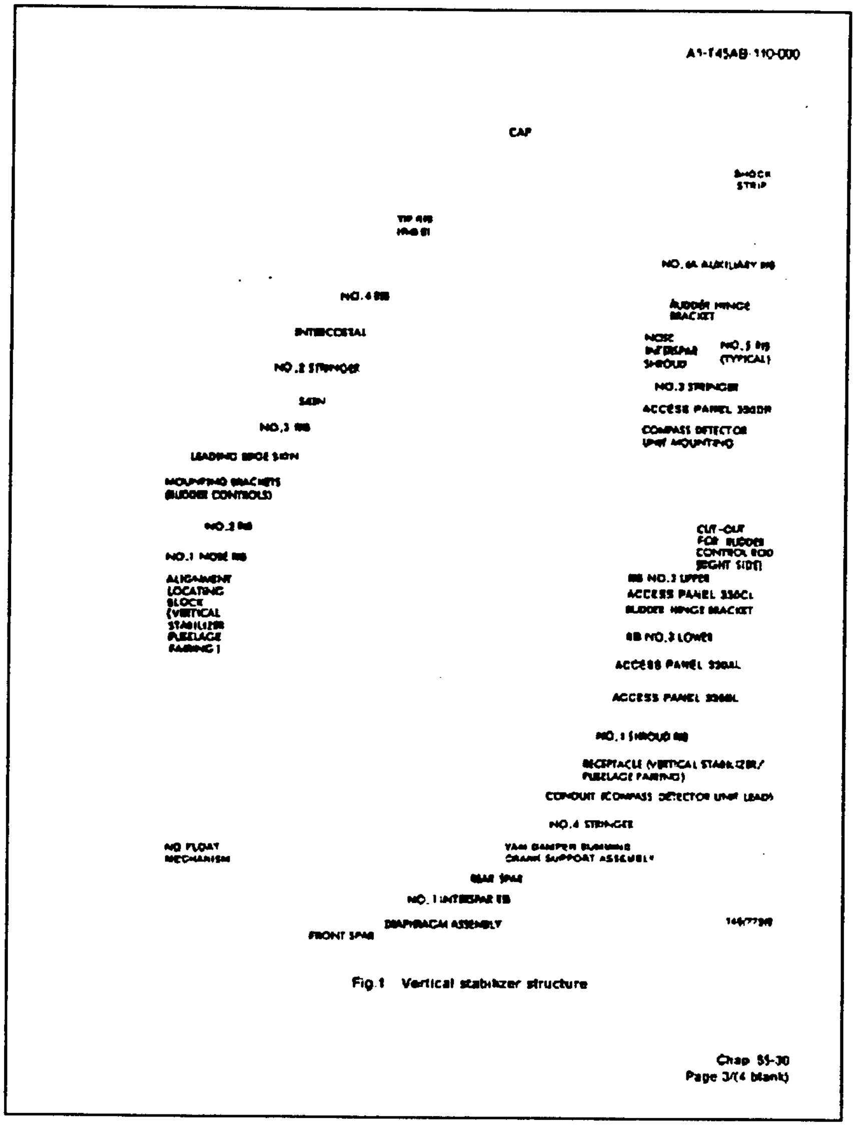


Figure 4.2.3-1 OCR Initial Evaluation – Test Image 1

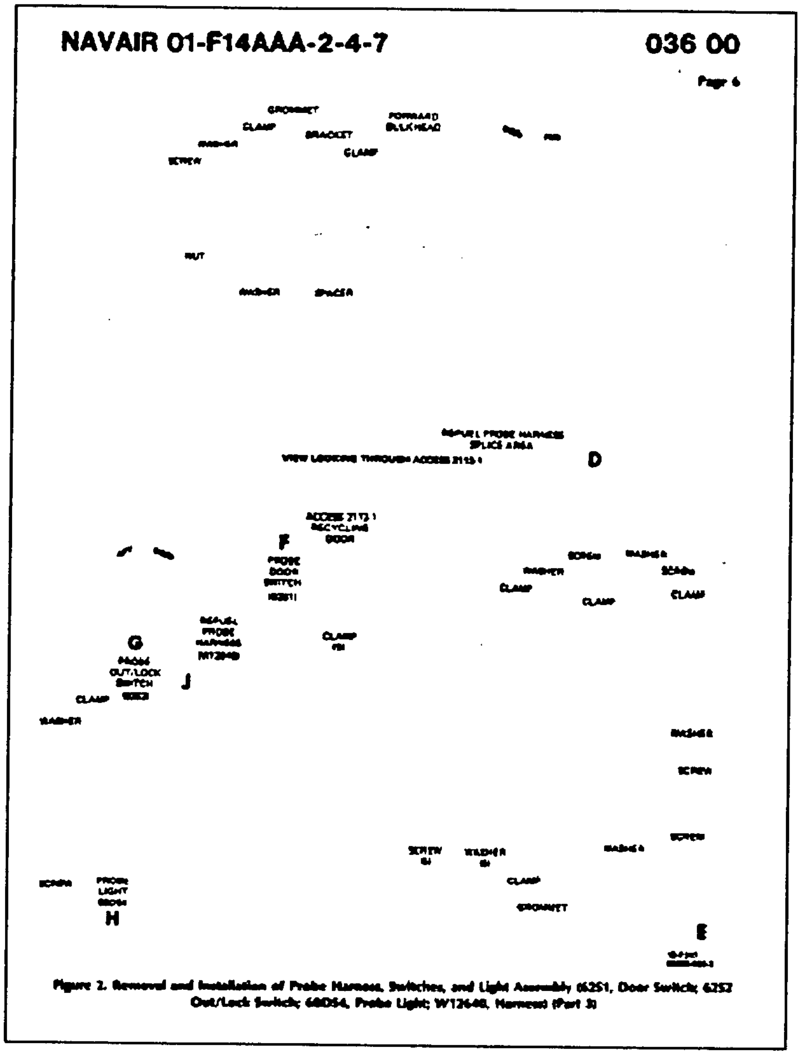
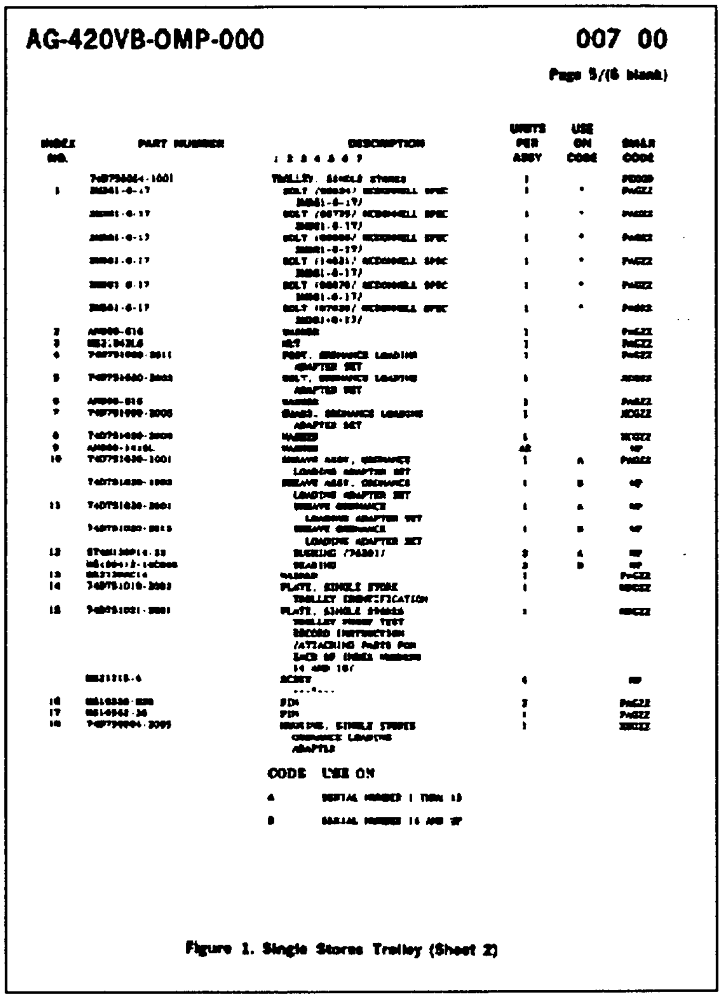


Figure 4.2.3-2 OCR Initial Evaluation – Text Image 2


AG-420VB-OMP-000 007 00

Page 5/(6 blank)

CODE USE ON

Figure 1. Single Stores Trolley (Sheet 2)

Figure 4.2.3-3 OCR Initial Evaluation – Test Image 3

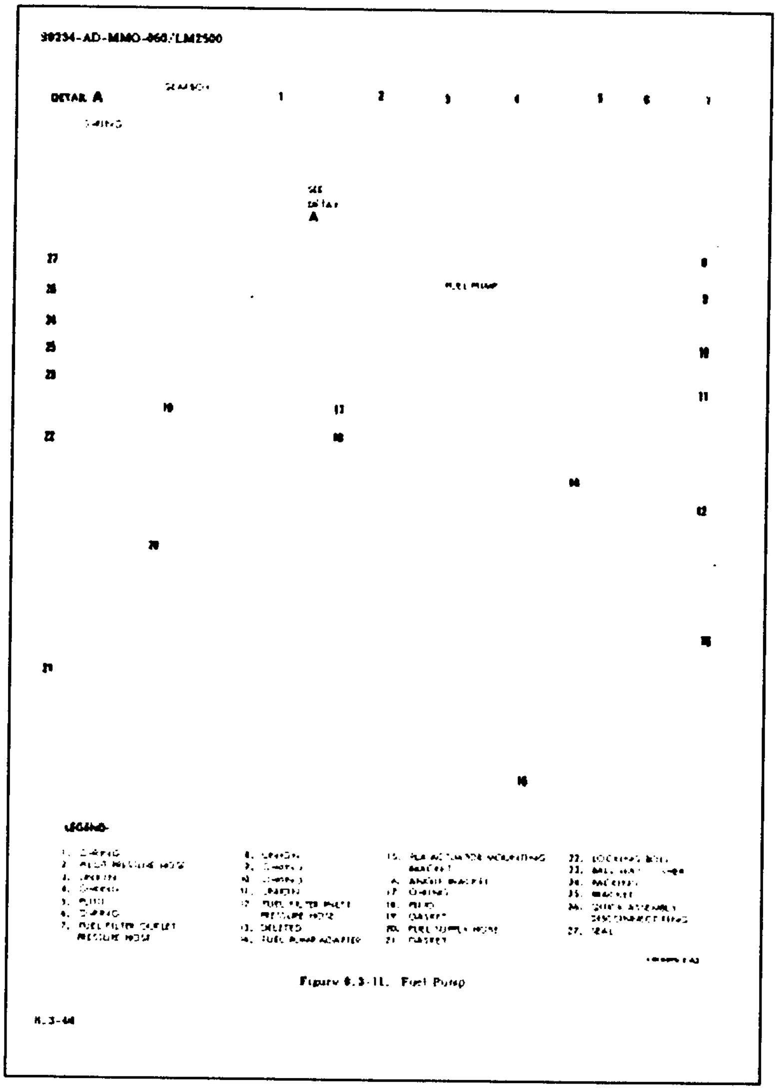
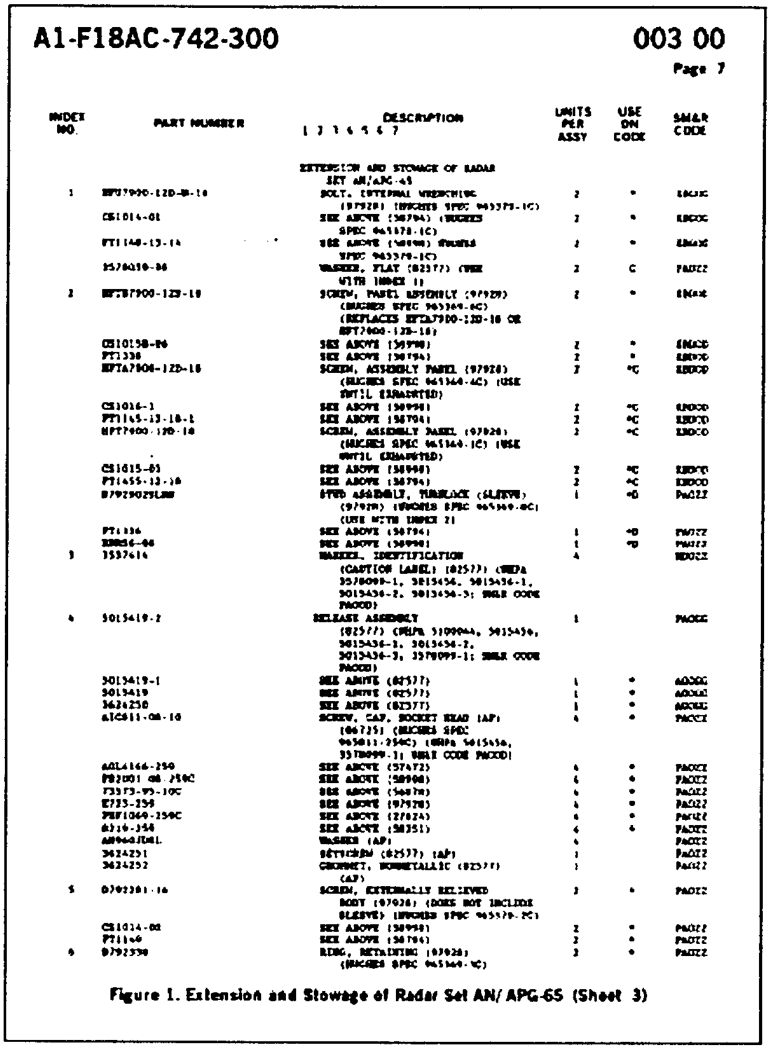


Figure 4.2.3-4 OCR Initial Evaluation – Test Image 4



A1-F18AC-742-300 003 00

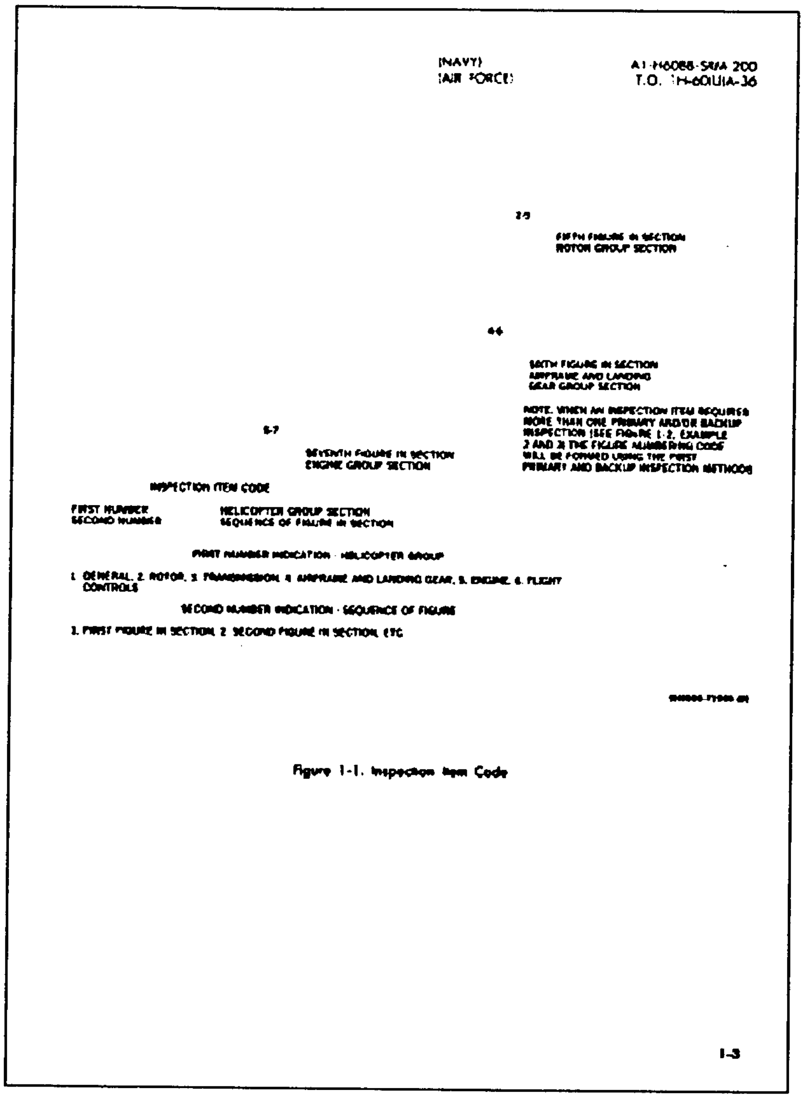
Page 7

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USE ON CODE	SM&R CODE

EXTENSION AND STOWAGE OF RADAR SET AN/APG-65

Figure 1. Extension and Stowage of Radar Set AN/APG-65 (Sheet 3)

Figure 4.2.3-5 OCR Initial Evaluation – Test Image 5



(NAVY) A1-H60BB-SRM 200
(AIR FORCE) T.O. 1H-60(U)A-36

2-5

FIFTH FIGURE IN SECTION
ROTOR GROUP SECTION

4-6

SIXTH FIGURE IN SECTION
AIRFRAME AND LANDING
GEAR GROUP SECTION

NOTE. WHEN AN INSPECTION ITEM REQUIRES
MORE THAN ONE PRIMARY AND/OR BACKUP
INSPECTION (SEE FIGURE 1-2, EXAMPLE
2 AND 3) THE FIGURE NUMBERING CODE
WILL BE FORMED USING THE FIRST
PRIMARY AND BACKUP INSPECTION METHODS

5-7

SEVENTH FIGURE IN SECTION
ENGINE GROUP SECTION

INSPECTION ITEM CODE

FIRST NUMBER HELICOPTER GROUP SECTION
SECOND NUMBER SEQUENCE OF FIGURE IN SECTION

FIRST NUMBER INDICATION - HELICOPTER GROUP

1. GENERAL, 2. ROTOR, 3. TRANSMISSION, 4. AIRFRAME AND LANDING GEAR, 5. ENGINE, 6. FLIGHT CONTROLS

SECOND NUMBER INDICATION - SEQUENCE OF FIGURE

1. FIRST FIGURE IN SECTION, 2. SECOND FIGURE IN SECTION, ETC.

Figure 1-1. Inspection Item Code

1-3

Figure 4.2.3-6 OCR Initial Evaluation – Test Image 6

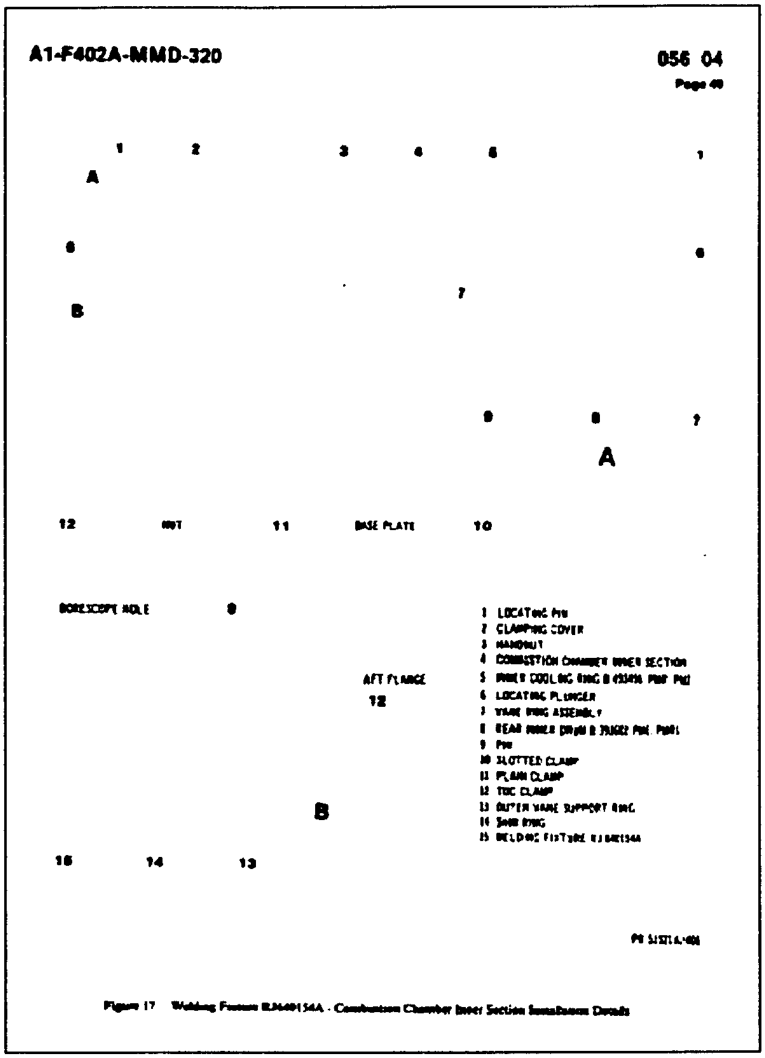


Figure 4.2.3-7 OCR Initial Evaluation – Test Image 7

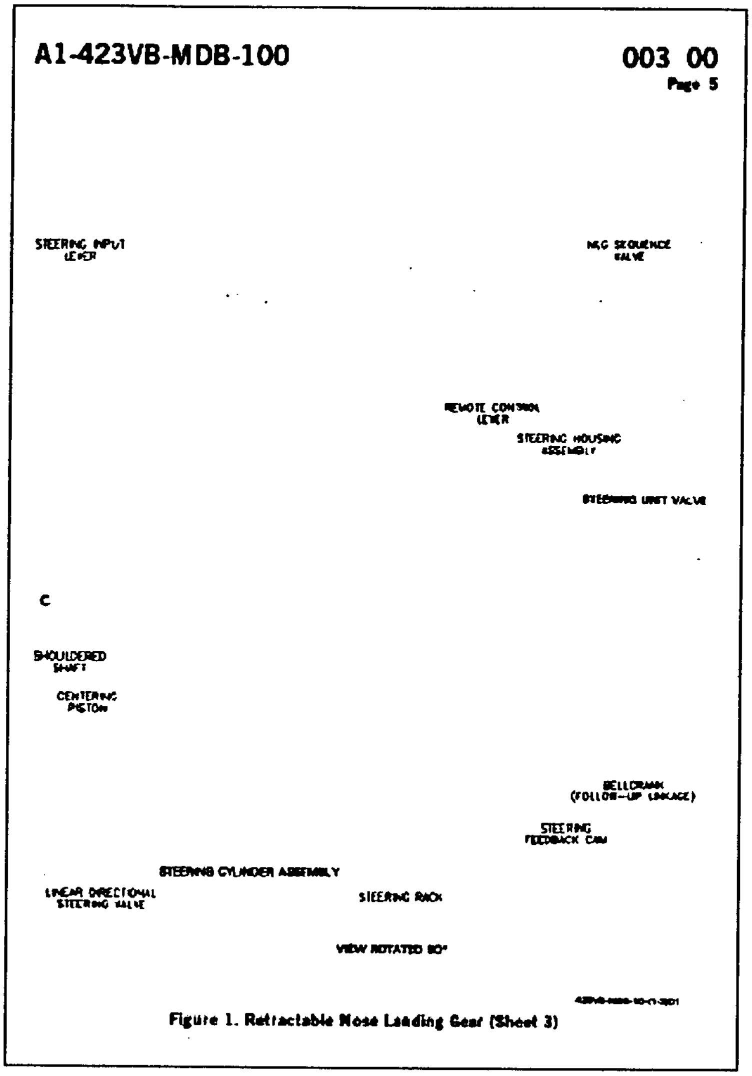


Figure 4.2.3-8 OCR Initial Evaluation – Test Image 8

Figure 4.2.3-9 shows the overall results of the OCR testing. Keep in mind that the ExperVision, INM, and Cognitive Technology products are integrated products and not Software Development Kits (SDK). Since ExperVision did so well, we have contacted the company in order to get an evaluation copy of their SDK to see if it performs as well.

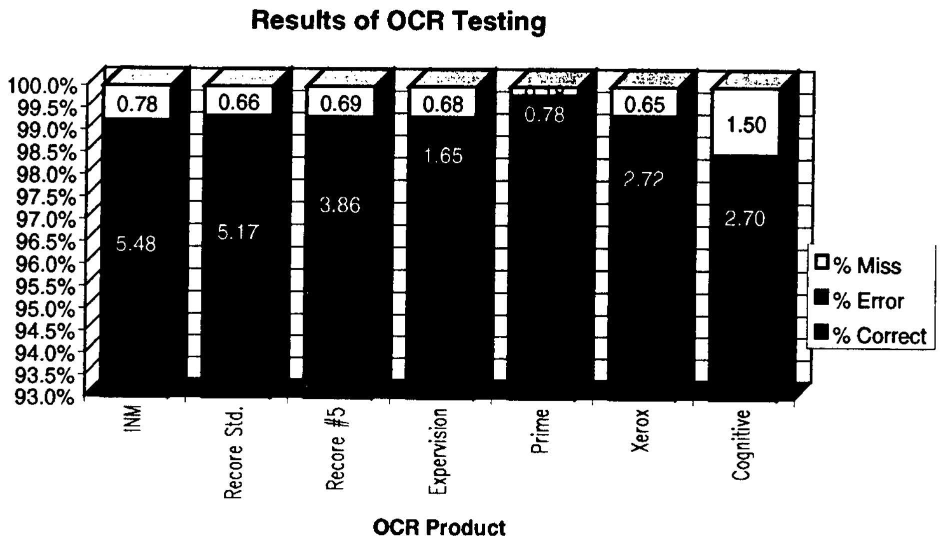


Figure 4.2.3-9 Results of the Initial OCR Engine Evaluation

As you can see, accuracy varied from 93.74% to 99.04%. Speed, however, didn't vary quite as much. All of the engines ran reasonably fast except for the engine from Prime Recognition, which was extremely slow. The reason for this is that Prime Recognition uses a voting technology that incorporates five different OCR engines taking the results and deciding which engine is correct (in the case of any discrepancies). This is also the reason for Prime's high accuracy rate. INM would often mistake a 1 for an I and a P for an F. The Recore engine from Maxsoft-Ocron had a lot of trouble with spacing. The product from Cognitive Technology dropped many words, which adds up to a lot of misses accounting for the high percentage of missed text.

4.2.4 Final Evaluation

The second evaluation consisted of running approximately 116 images from four different troubleshooting manuals were run through the following engines: Prime Recognition, ExperVision, and Xerox. First, using a modified version of the GCS project, graphics were removed from the images. This resulted in an image that most closely resembles the one an engine would see in our final application. In the second evaluation, only edits will be counted. An edit is either a block delete or any change made to a character.

The following table illustrates the results of the second evaluation. Clean images are those that have clearly distinguishable text and little or no graphics. Dirty images are those where the text runs together or graphics are predominant.

Table 4.2.4-1 OCR Final Evaluation Results

A1-F18AC-744-210	ExperVision	Prime Recognition	Xerox
Clean Images			
1-00p1	3	8	16
2-00p2	20	3	53
3-00p17	5	1	11
3-00p4	21	9	31
4-00p10	13	8	35
4-00p7	7	13	61
4-00p8	22	16	33
5-00p7	17	17	69
5-00p8	18	16	59
7-00p25	23	24	26
7-00p53	34	19	78
8-00p3	13	14	23
Total edits	**196**	**148**	**495**
Avg. edits per page	**16.33**	**12.33**	**41.25**
Dirty Images			
3-00p21	22	17	24
3-00p23	34	19	13
3-00p27	6	9	20
4-00p2	118	118	247
4-00p3	62	110	243
Total edits	**242**	**273**	**547**
Avg. edits per page	**48.40**	**54.60**	**109.40**
Total edits this manual	**438**	**421**	**1042**
Avg. edits per page this manual	**25.76**	**24.76**	**61.29**

Table 4.2.4-1 OCR Final Evaluation Results (continued)

A1-F18AC-510-200	ExperVision	Prime Recognition	Xerox
Clean Images			
2-00p1	19	5	29
2-00p2	18	13	66
2-00p3	8	6	23
2-00p5	13	4	11
2-00p6	22	28	16
3-01p14	11	9	16
3-01p16	2	0	1
3-01p2	9	3	18
3-01p8	4	3	20
4-00p12	8	5	36
4-00p14	16	20	41
5-00p6	10	11	73
6-00p14	8	4	62
Total edits	**148**	**111**	**412**
Avg. edits per page	**11.38**	**8.54**	**31.69**
Dirty Images			
4-00p2	35	34	37
Total edits	**35**	**34**	**37**
Avg. edits per page	**35.00**	**34.00**	**37.00**
Total edits this manual	**183**	**145**	**449**
Avg. edits per page this manual	**13.07**	**10.36**	**32.07**

Table 4.2.4-1 OCR Final Evaluation Results (continued)

A1-F18AC-450-200	ExperVision	Prime Recognition	Xerox
Clean Images			
2-00p1	6	13	12
2-00p2	4	1	23
2-00p3	4	7	6
2-00p4	1	3	2
2-00p5	1	0	3
2-00p6	7	3	3
3-00p15	7	1	10
3-00p18	3	2	16
3-00p49	1	2	40
3-00p57	2	1	6
4-00p9	8	5	33
Total edits	**44**	**38**	**154**
Avg. edits per page	**4.00**	**3.45**	**14.00**
Dirty Images			
2-00p8	31	74	75
3-00p77	100	19	41
3-00p79	60	19	52
4-00p4	20	24	39
4-00p5	258	115	140
Total edits	**469**	**251**	**347**
Avg. edits per page	**93.80**	**50.20**	**69.40**
Total edits this manual	**513**	**289**	**501**
Avg. edits per page this manual	**32.06**	**18.06**	**31.31**

Table 4.2.4-1 OCR Final Evaluation Results (continued)

NAVAIR 01-S3AAA-2-3.2	ExperVision	Prime Recognition	Xerox
Clean Images			
10-00p10	21	17	25
10-00p11	24	56	49
10-00p13	8	7	18
10-00p2	8	5	15
10-00p3	3	0	5
10-00p5	18	12	26
10-00p8	12	5	193
11-00p2	14	11	16
11-00p3	5	6	22
3-00p18	10	1	23
3-00p26	23	1	10
3-00p3	1	0	3
3-00p6	21	8	22
4-02p9	14	3	11
Total edits	**182**	**132**	**438**
Avg. edits per page	**13.00**	**9.43**	**31.29**
Dirty Images			
10-00p4	31	24	35
3-00p7	18	21	31
4-01p6	15	15	39
4-02p6	6	36	23
Total edits	**70**	**96**	**128**
Avg. edits per page	**17.50**	**24.00**	**32.00**
Total edits this manual	**252**	**228**	**566**
Avg. edits per page this manual	**14.00**	**12.67**	**31.44**

Table 4.2.4-1 OCR Final Evaluation Results (continued)

	ExperVision	Prime Recognition	Xerox
Grand total edits (clean)	570	429	1499
Grand total edits (dirty)	816	654	1059
Grand total edits	1386	1083	2558
Avg. edits per page (clean)	11.40	8.58	29.98
Avg. edits per page (dirty)	54.40	43.60	70.60
Avg. edits per page (all)	21.32	16.66	39.35

Clearly, from the results of the second evaluation, our choices were down to either Prime Recognition or ExperVision. Prime Recognition's accuracy may have slightly outperformed ExperVision, but it was not by a big enough margin to justify the high cost overhead associated with Prime. The following table shows the cost for each of the OCR engines. (The accuracy percentages in the following table are from the previous run of eight images.)

Table 4.2.4-2 Accuracy Cost Comparison

Company	Accuracy	Errors	Cost (SDK)	Cost (seat)	Cost (other)
Prime Recognition	99.04%	64	$27,000	N/A	$13,000
ExperVision	97.67%	155	$4,190	$765	N/A
Xerox	96.64%	224	$5,000	$100	N/A
Maxsoft-Ocron	95.45%	323	$6,000	$300	N/A

Accuracy was measured on images that had the graphics completely removed.
Seat cost is for 50 seats.
Other costs are for other hardware, software, etc. required to run the engine.
Only the top three engines are being evaluated on the troubleshooting images.

While accuracy was the biggest issue, cost, speed, and robustness were also major concerns. As you can see in the above table, ExperVision is much cheaper than Prime The big problem with Prime's cost is that the $40,000 would be incurred for each new installation of the product. That results from the cost of the runtime files and an additional $13,000 for a dedicated dual Pentium server to run it. Once installed, however, it is accessible over the network and the only variable that limits the number of users is the processing power of the server. A dual Pentium pro server could handle about 3,000 to 4,000 images per day. ExperVision's cost per runtime seat is variable. Table 4.2.4-3 illustrates their royalties:

Table 4.2.4-3 ExperVision's RTK Royalty

Toolkit	Open RTK 3.0XA for Windows NT
Toolkit Price	$4,190
After this number of copies	Royalty per copy is down to
3	$1,080
5	$1,044
10	$995
15	$948
20	$882
30	$765
50	$617
75	$485
100	$381
125	$300
150	$212
200	$164

Xerox's runtime fees, however, are significantly more affordable with a price of $100 per seat for up to 100 seats. Once the number of seats exceeds 100, the price per seat drops to $50.

As far as speed is concerned, ExperVision and Xerox run at around the same speed, which is approximately five times faster than Prime. This was due to Prime's need to load and run five different OCR engines (including ExperVision).

Robustness was another primary concern. ExperVision's engine had trouble with certain directory structures, but their technical support seemed to know what was causing the problem and said a patch would be forthcoming. Prime, on the other hand, was much less robust. On two occasions, Prime crashed so badly that the user was forced to reboot in order to get it working again. Furthermore, on every image that Prime was run, at least one of the five OCR engines failed. Numerous times only one engine succeeded on the image. In addition, Prime had a terrible time merging the results of the various engines together. Many duplicate lines would appear when it didn't know which engine to believe. The people from Prime said this could be fixed with an extra zoning module that cost around $4,000 (included in the $27,000 previously mentioned). While Prime's voting technology is a good idea, they need to work on their implementation.

4.2.5 Demo Application

Overall, ExperVision was chosen over Prime Recognition. Work was then started on a generic interface for the engine, as well as an application to test the interface. This application implemented a new blob segmentation technology to perform the separation of graphics and text. After that was accomplished, the blobs remaining on the image were then grouped into lines. This was done using a new blob text grouping strategy. The results of the segmentation and grouping were then sent to the OCR engine for processing.

The demo application also provided a means to manually separate text and graphics then recognize the text and save the results to a file. Additionally, it allowed the results to be viewed by overlaying them on the original image. Furthermore, regions, lines, words, and characters found by the engine could be viewed on the screen by showing the bounding box. At this point, preparations began for the demonstration. All experimental code was removed from the demo application. Graphical user interface enhancements were added to the program to provide a better means of showing exactly what kind of processing was done to the image. A variety of images were selected to show the capabilities of the OCR engine, as well as the improvement of recognition results when blob segmentation and grouping is used prior to processing the image.

Figures 4.2.5-1 through 4.2.5-5 show the process an image goes through during recognition.

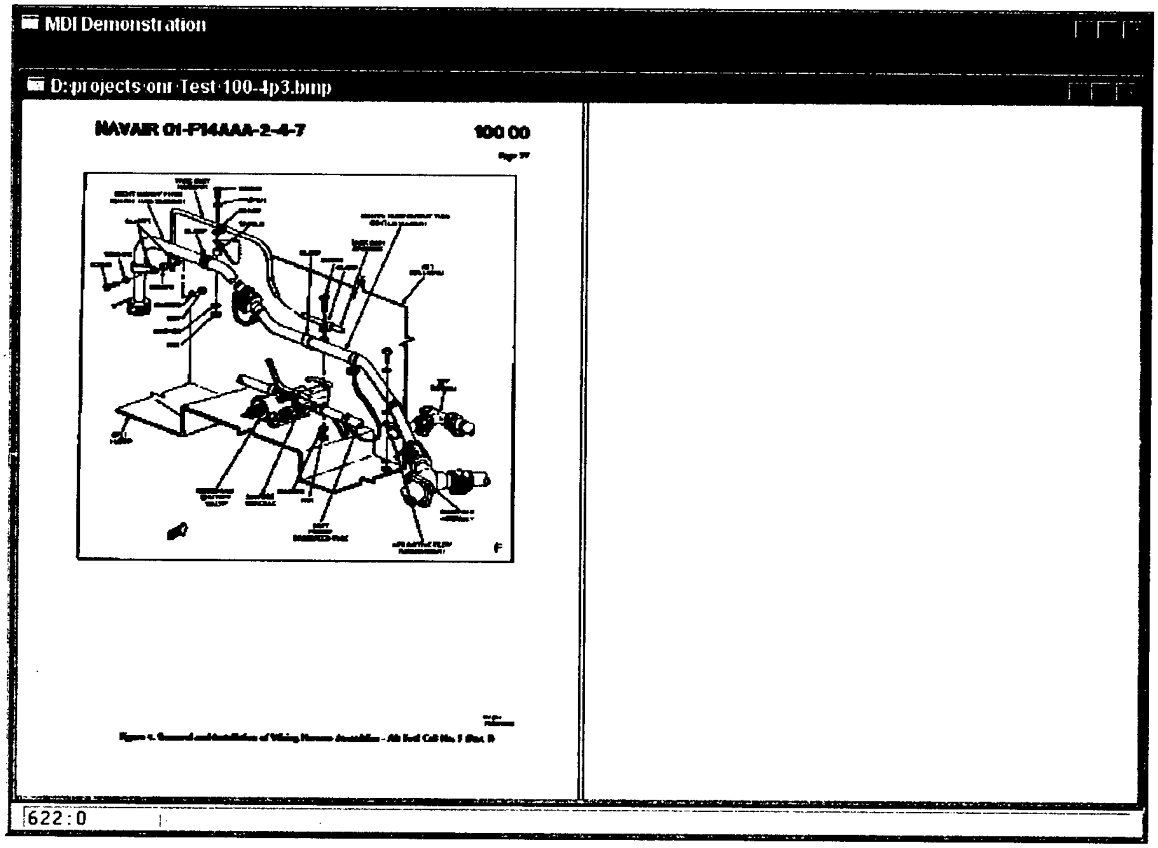


Figure 4.2.5-1 The Original Image Prior to Any Processing

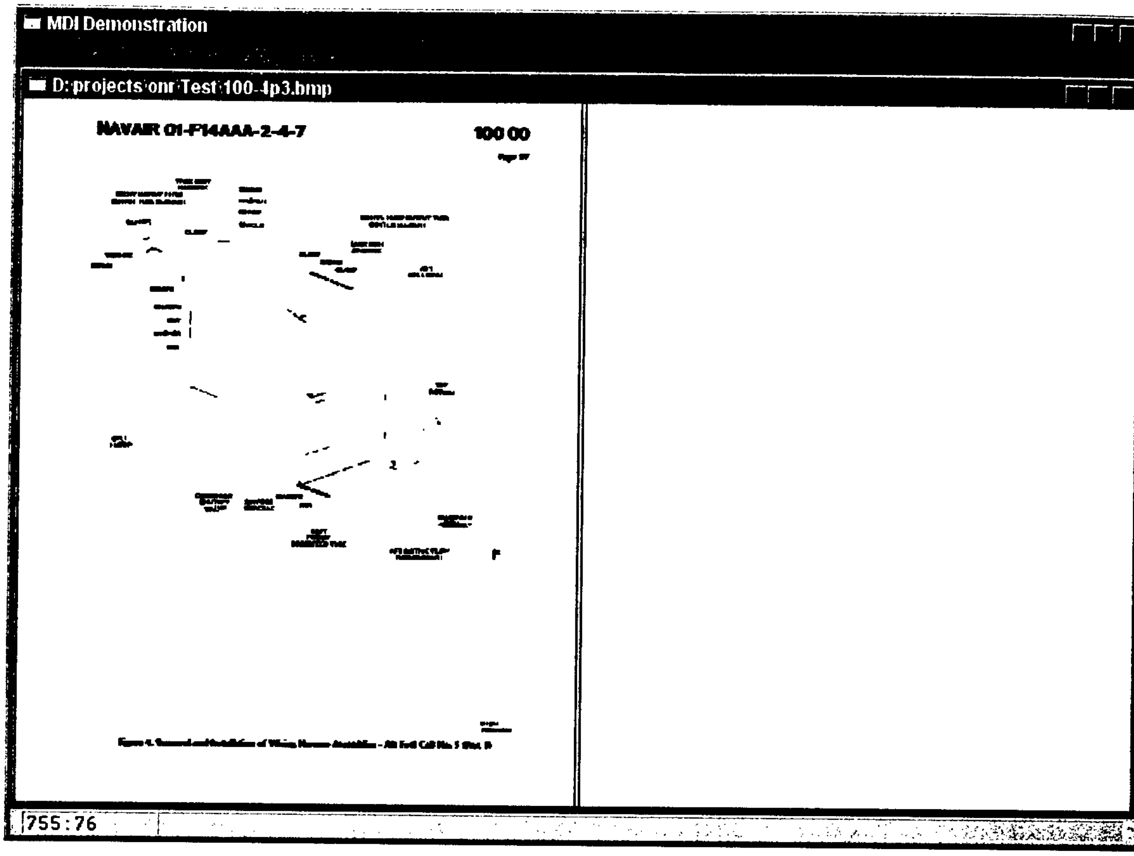


Figure 4.2.5-2 The Image After Applying the Blob Segmentation Technology

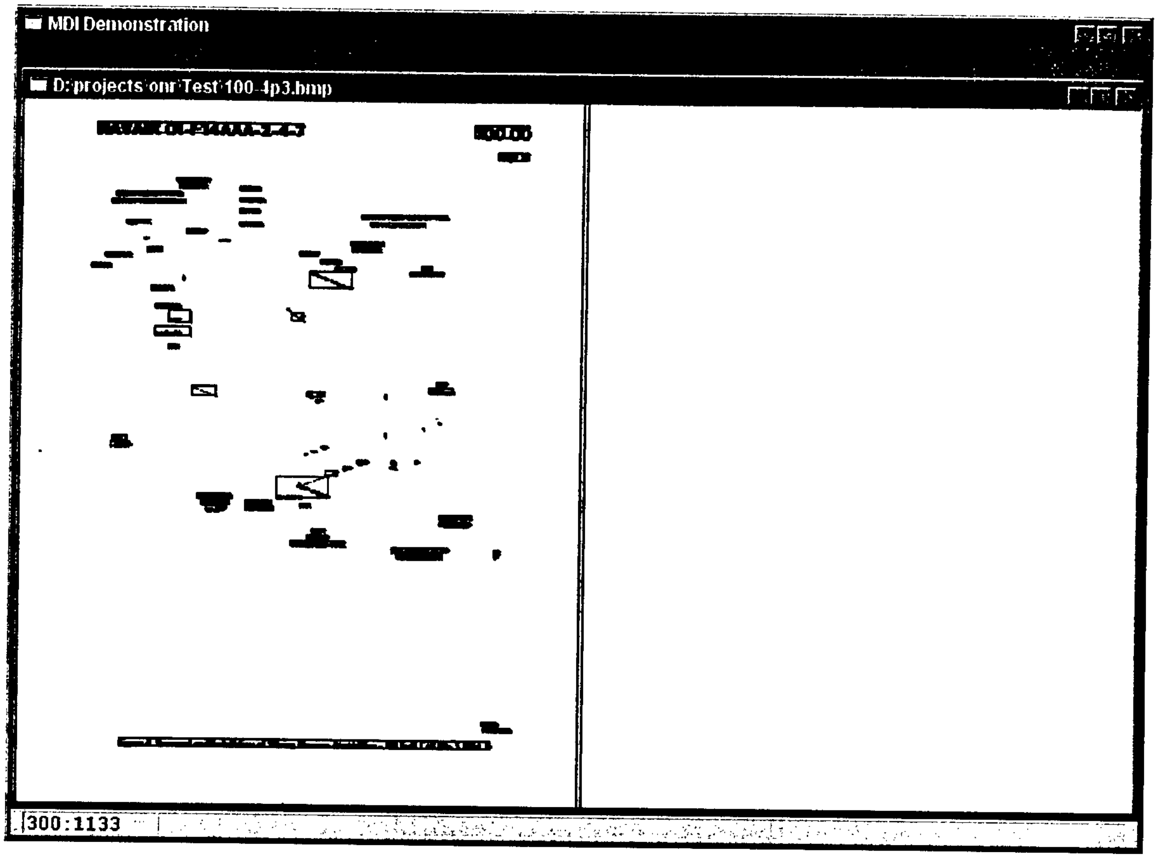


Figure 4.2.5-3 The Image After Applying the Blob Text Grouping Strategy

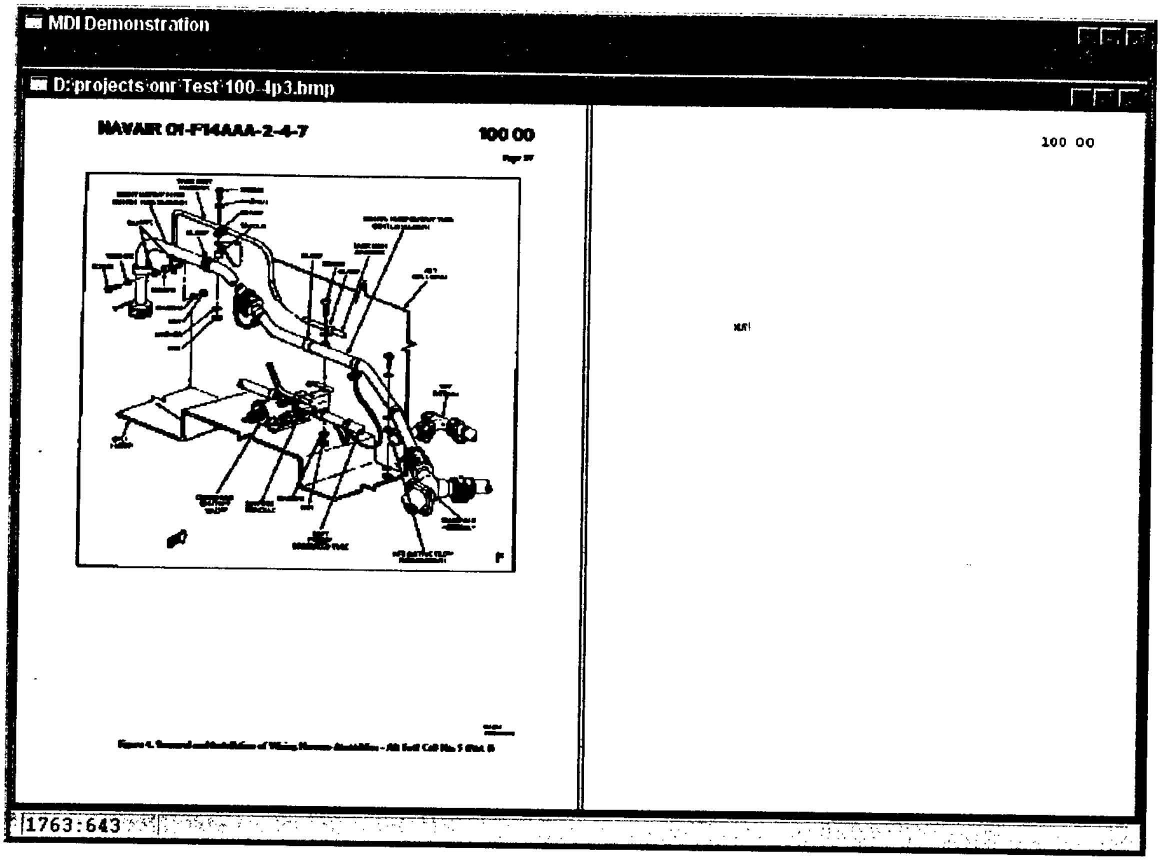


Figure 4.2.5-4 The Text Returned from the ExperVision OCR Engine

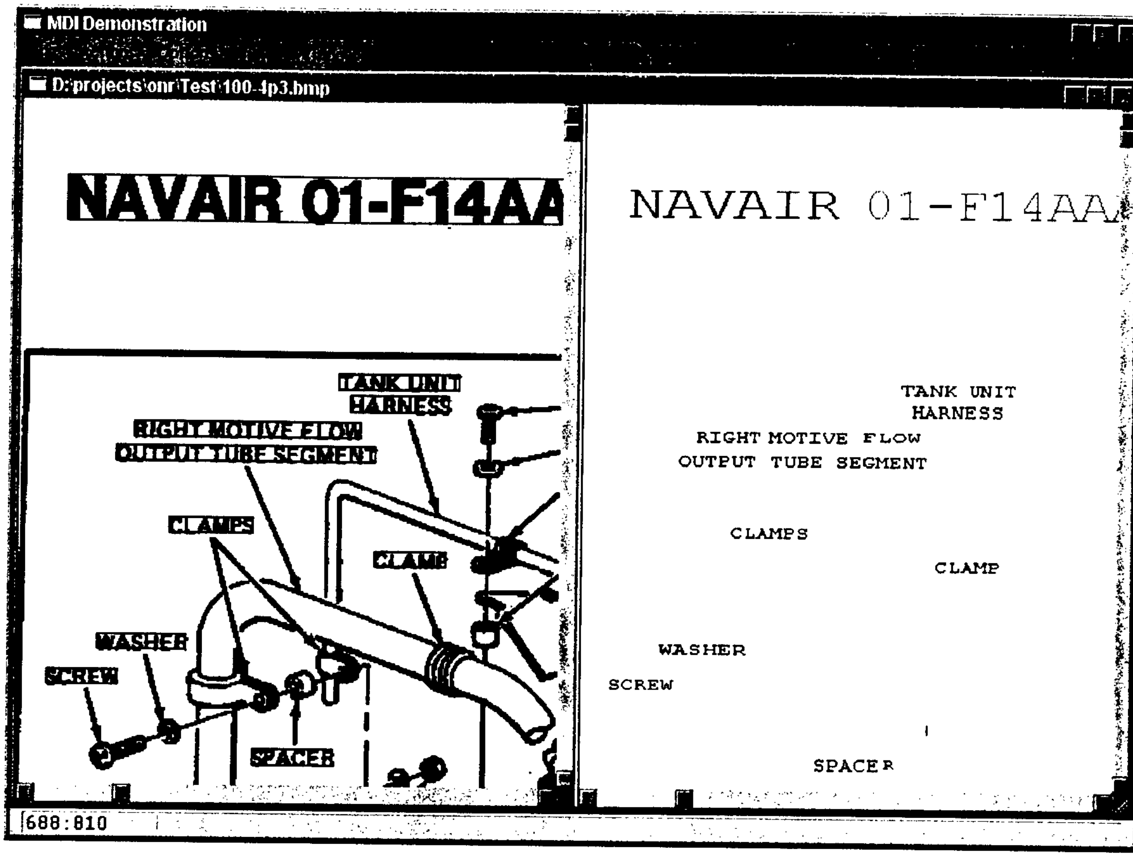


Figure 4.2.5-5 Zoomed In on Recognized Text With Regions Highlighted

After the demonstration, advancements were made toward a continuation of the project. The code that provides an interface for the OCR engine has been moved into a Dynamic Link Library (DLL) to allow for easier integration into a larger project.

4.2.6 Future Directions

The importance of graphic removal to the text recognition process can not be emphasized enough. Were this project to continue, different methods of text and graphics segmentation would be examined. In particular, we would investigate the separation process used in the GCS project to determine whether or not it's use would be beneficial to us.

Furthermore, we would look for ways to reduce the number of junk hits (graphics recognized as text) returned from the recognition process. Some approaches to this would be filtering out unacceptable characters, character combinations that make no sense, and characters that are repeated more than they should be For example, an unacceptable character might be a question mark (or ampersand, or percentage sign, etc.) by itself in the middle of the page. An example of character combinations that make no sense might be something like the following string: *)@,,,.* The same example can be used to show characters being repeated more than they should be. In the previous example, three commas in a row clearly signify that something is wrong with this string. The big question is whether any of these cases were originally graphics or not. After

processing numerous images, there seems to be a high probability that character combinations that make no sense were previously graphics. However, this is dependent on the fact that there are *no* alphabetic letters in the word. When these types of characters appear in the word, then determining this is not as easy.

4.3 Vector Analysis in Table Processing

As discovered from the survey conducted at the onset of the project, a large percentage (62.5% of pages surveyed) of the data contained in troubleshooting information is presented in a table format. Much of the structure of the procedural troubleshooting steps is contained within the relationships established by the table columns and rows. Vector analysis of the troubleshooting information can be used to extract many of the graphical features of tables, in order to identify proper text groupings, and relationships between these proper text groupings.

Figure 4.3-1 shows a typical page of troubleshooting information organized in a table format. You can see that the text, highlighted by a dotted box (not part of the original image), in Columns 6 and 7 of the table, is very close. By simply using proximity to combine isolated text blocks, it would probably be combined as "TEST INITIATE - Dimly lit." However by using the information gained by vector analysis, we would know the bounds of Column 6 and of Column 7, and that the text in each of these columns is separate, regardless of proximity. This is one example of how vector information can be useful in the conversion process.

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TABLE 1. TURN ON TEST SUMMARY (cont)						
Operator Commands				Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
d.		DVOM/SCOPE ON/OFF	Set to ON			None
e.	DVOM	POWER/OFF	Set to POWER	DVOM	Display	Lit
f.		MODE	Set to REMOTE			None
g.		RANGE	Set to AUTO			None
h.	ANTENNA SIMULATOR	ON	Press	ANTENNA SIMULATOR	ON	Lit
i.	RO UMD	IND PWR/ON	Press	RO UMD	IND PWR ON	Brightly lit
					IND PWR OFF	Off
					TEST INITIATE DEFL AMPL	Brightly lit
j.	RO UMD	TEST INITIATE-DEFL AMPL	Press	RO UMD	TEST INITIATE-DEFL AMPL	Dimly lit
					FAILURE UMD, EMDU, ADU, and MPS	Off
					OVERHEAT UMD, EMDU, ADU, and MPS	Off
k.	RO UMD VIDEO INT-RADAR	SYNTH	Rotate fully clockwise			None
l.		SP	Rotate fully clockwise			None
m.		AMTI	Rotate fully clockwise			None
n.	ACU	ANT AZ SOURCE	Set to RO	ACU	ANT AZ SOURCE	Displays RO

Figure 4.3-1 Table Troubleshooting Information

Upon initial inspection, the problem of recognition of table rows and columns may sound simple. You would just recognize the rectangles. However, upon further inspection of actual tables contained within troubleshooting information, several variations of tables can be identified. They appear similar, but in the vector representation, they are very different. These include variations of the frame, and interruptions of the columns. A simple matrix showing the possible graphical table variations is shown in Table 4.3-1.

Table 4.3-1 Possible Graphical Table Variations

	Complete Columns	**Incomplete Columns**
Complete Frame	Examples Exist	Examples Exist
Incomplete Frame	Examples Exist	Examples Exist
No Frame	Examples Exist	No Examples Exist

Table 4.3-1 shows that examples have been found of five different graphical table variations. The sixth, no frame with incomplete columns, has not been identified in the troubleshooting information. However, it would exhibit such a small amount of graphical structure, that vector analysis would be very ineffective in this case. Normal text based analysis, identifying text columns and paragraphs, would be more beneficial in the last case.

The simplest case is shown in Figure 4.3-2. This case contains a completely framed table, with rectangular columns and no column interruptions by notes or cautions.

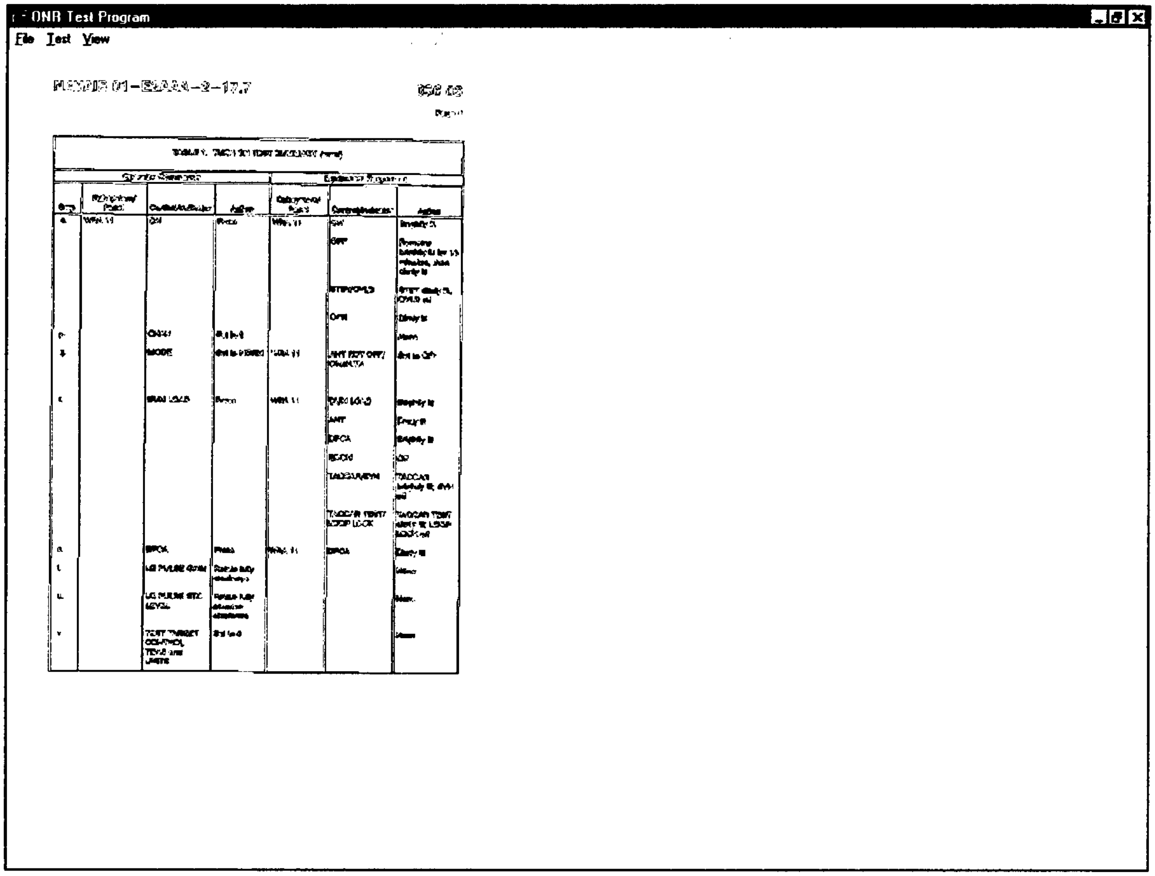

Figure 4.3-2 Table With Complete Frame and Complete Rectangular Columns

In this case, complete rectangles are identified within the image, and this leads to identification of all columns and rows in the table. The process in this case can be summarized as follows:

1. Recognize all complete rectangles in the image.

The results of this recognition are shown in Figure 4.3-3.

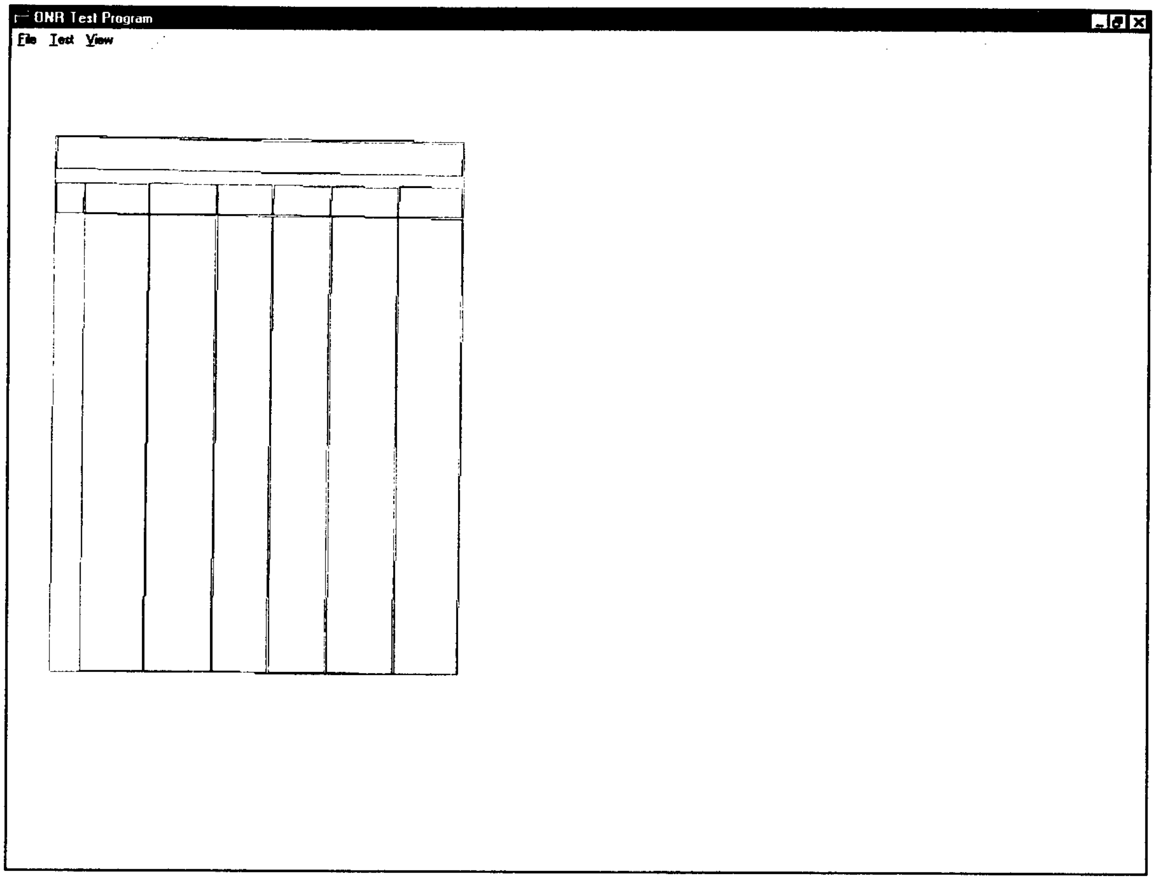

Figure 4.3-3 Results of Finding Columns for Table Shown in Figure 4.3-2

The second type of table encountered is one where the table frame is incomplete, as to signify that the table is continued on another page, but the columns are complete, spanning the entire height of the table. An example of this is shown in Figure 4.3-4.

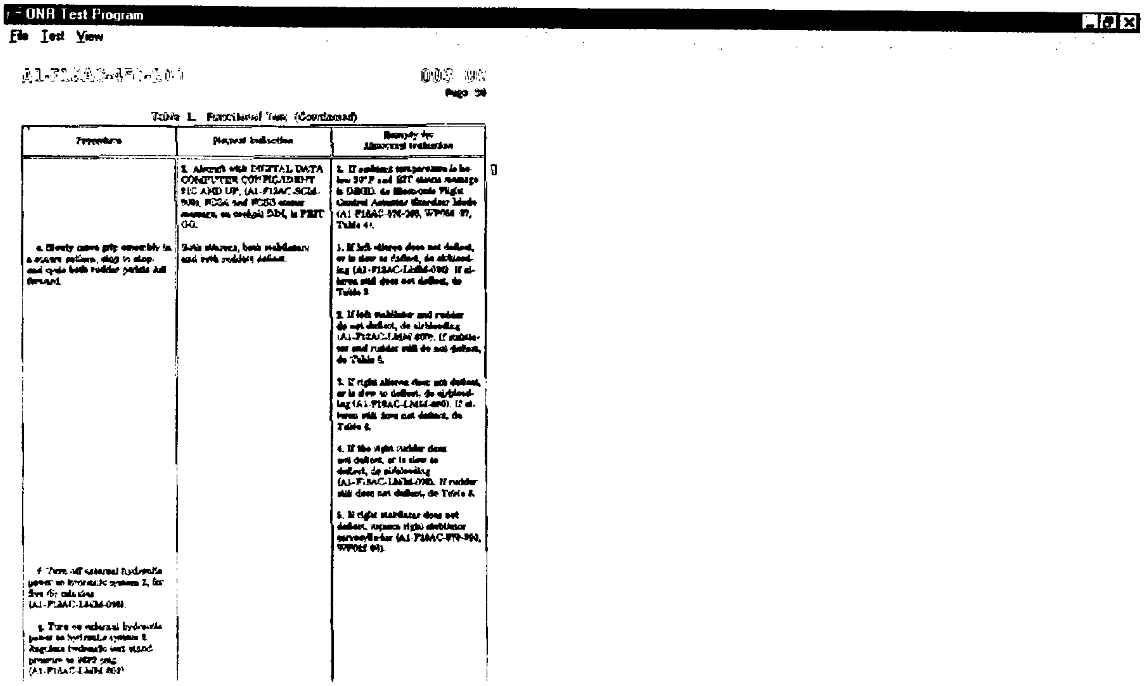

Figure 4.3-4 Table With Incomplete Frame, Complete Columns

In this case, the complete rectangles would again be recognized. However, that would give us only the three columns in the first row at the top. The remaining three columns would remain unrecognized. So further analysis is required. All verticals and horizontals in the remaining polyline would be identified and sorted, starting with the leftmost vertical. Then this sequence of horizontal and vertical lines would be searched for special sequence combinations. A sequence combination of Vertical-Horizontal-Vertical possibly denotes three sides of a rectangle. If closing these three sides yields a rectangle, then this is taken to be another column. The process can be summarized as follows:

1. Recognize all complete rectangles within the image.
2. Identify all verticals and horizontals.
3. Search for Vertical-Horizontal-Vertical sequences.
4. Check closure of sequences for rectangularity.

The results of this process are shown in Figure 4.3-5.

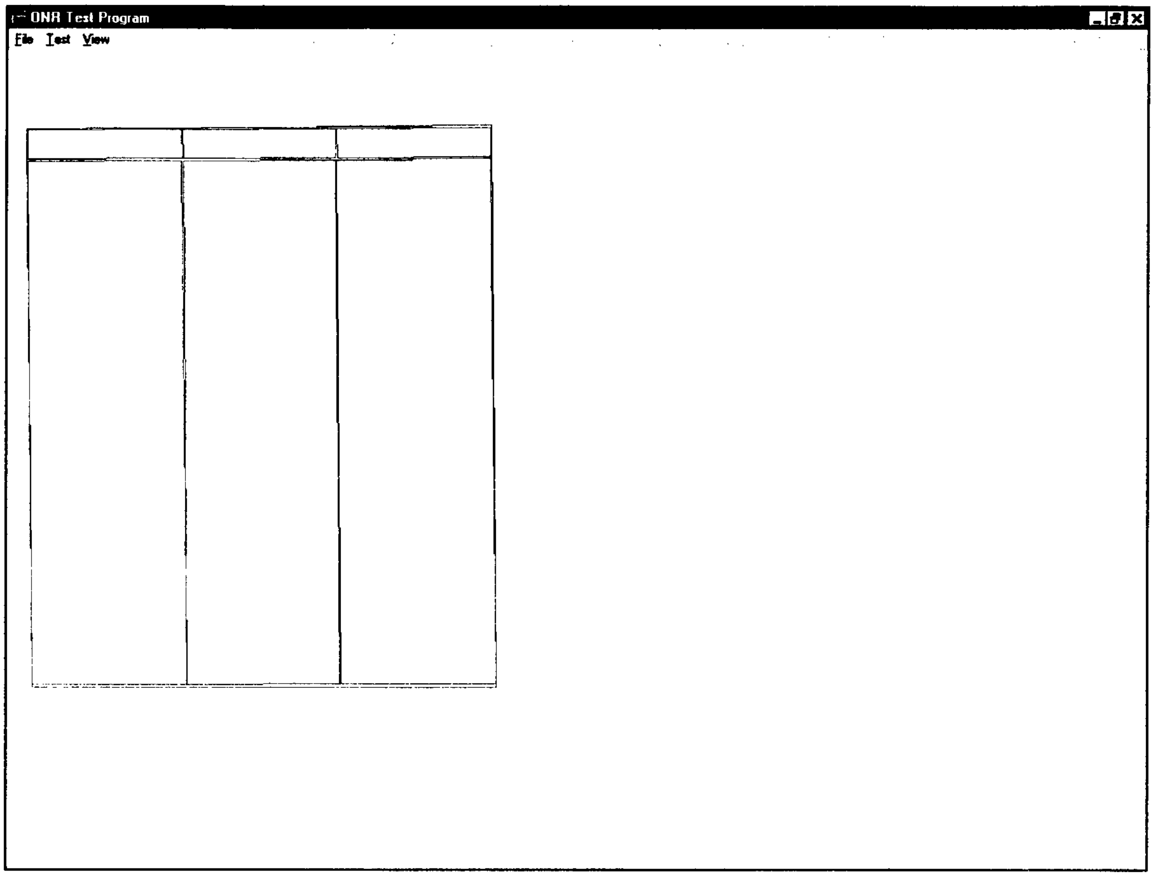

Figure 4.3-5 Results of Finding Columns for Table Shown in Figure 4.3-4

The third case exists where the table has a complete frame, but the columns are interrupted by the insertion of a note, or other information within the table. Therefore, the vector lines making up the column do not span the entire height of the column. An example of this is shown in Figure 4.3-6.

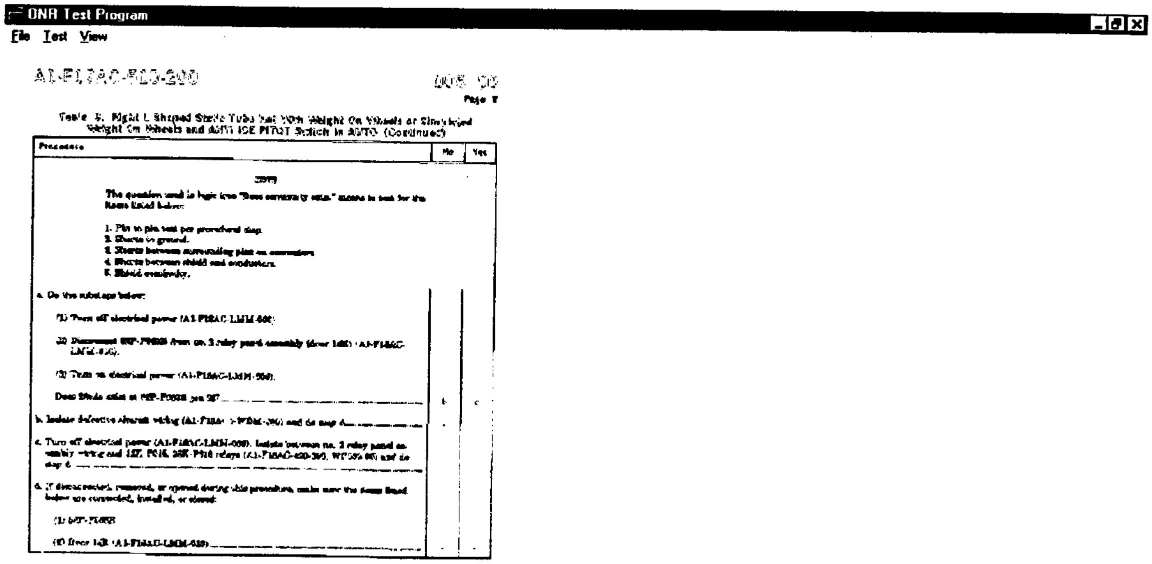

Figure 4.3-6 Table With Complete Frame and Incomplete Column

In this case, we would follow the process identified for the last case. However, this would give us only the three columns in row one at the top, as complete rectangles, and the columns in row 2, column 2, as a closed rectangular Vertical-Horizontal-Vertical (VHV) sequence. The other columns, row 2, column 1 for example can be identified as a VHV sequence. However, upon closure of the three lines, because the left vertical is much longer than the right, due to the column interruption, a rectangle is not formed. This is handled as a special case. If the VHV sequence encounters either the left or right table wall, then the left or right sequence line is shortened to the length of the other line in the sequence. The process can be summarized as follows:

1. Recognize all complete rectangles within the image.
2. Identify all verticals and horizontals.
3. Search for Vertical-Horizontal-Vertical sequences.
4. Check closure of sequences for rectangularity
5. If closure fails, check for inclusion of the left or right table wall in the VHV sequence
6. If left or right wall is included, allow rectangularity to be established.

The results of this process are shown in Figure 4.3-7.

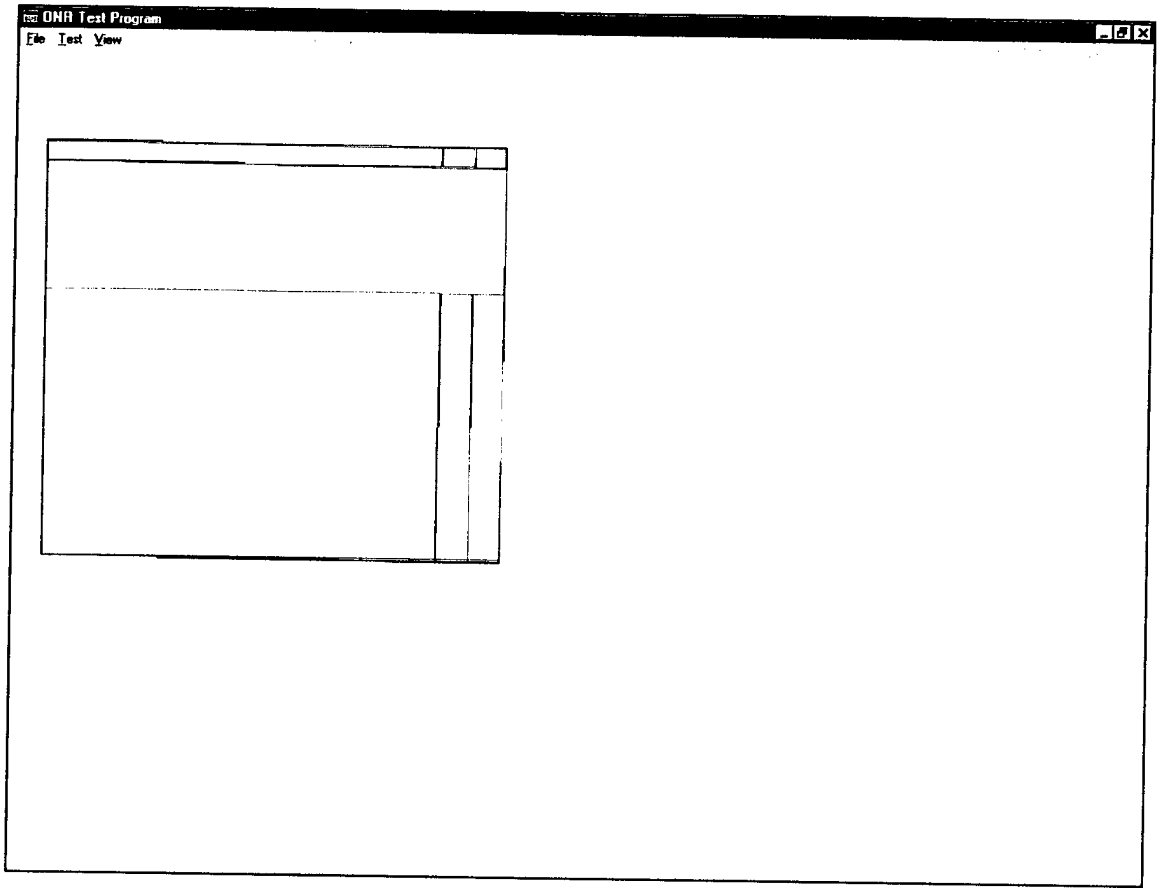

Figure 4.3-7 Results of Finding Columns for Table Shown in Figure 4.3-6

The fourth case exists where the table has both an incomplete frame, and incomplete columns, due to interruptions by insertion of notes. An example of this case is shown in Figure 4.3-8.

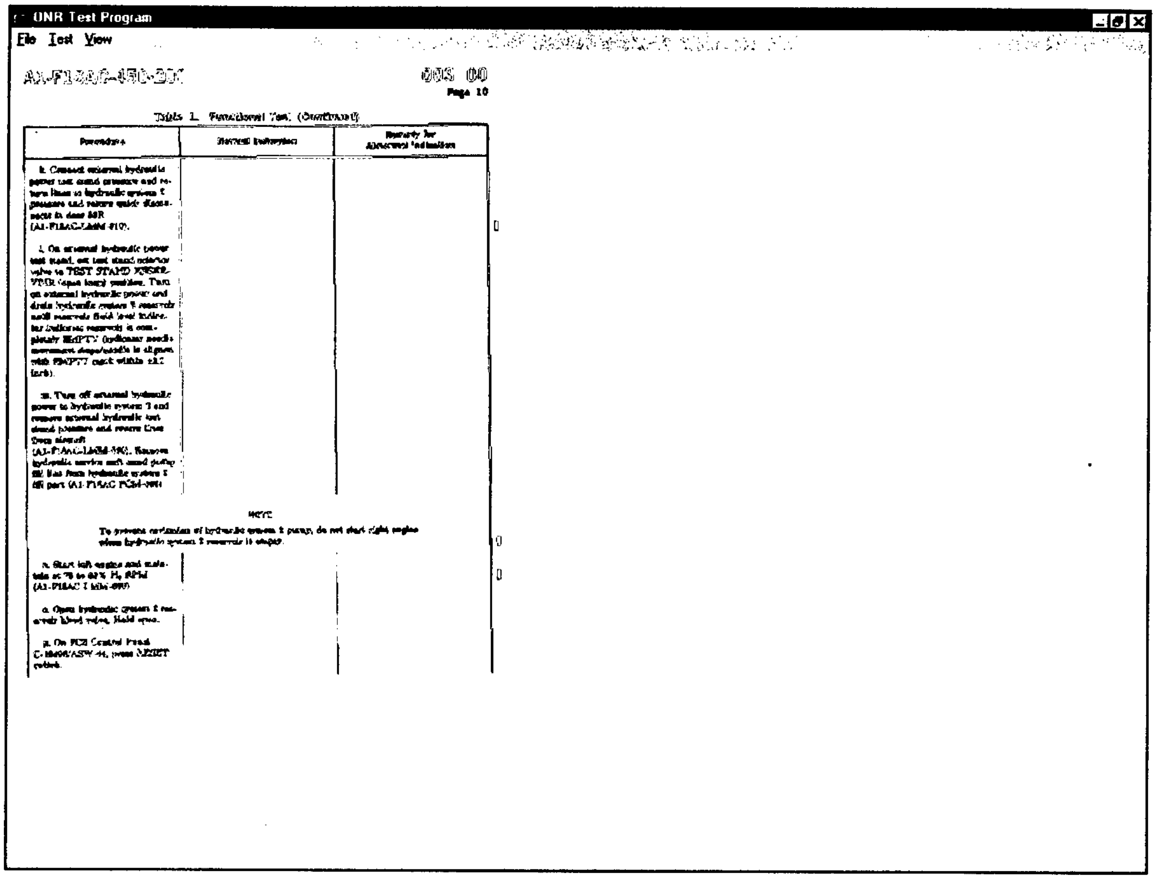

Figure 4.3-8 Table With Incomplete Frame and Incomplete Columns

Using the procedure outlined on the last example would identify the three columns at the top of the table in row 1, as well as the three columns in the middle in row 2. However, the three at the bottom would remain unidentified. In order to handle this, isolated vertical polylines are identified existing within the bounds of a large polyline, known to be part of the table. These isolated verticals are then sorted left-right, top-bottom. Once this is done, the isolated verticals are assembled with the left and right table walls, and each other to establish the remaining columns. The process can be summarized as follows:

1. Recognize all complete rectangles within the image.
2. Identify all verticals and horizontals.
3. Search for Vertical-Horizontal-Vertical sequences.
4. Check closure of sequences for rectangularity.
5. If closure fails, check for inclusion of the left or right table wall in the VHV sequence.
6. If left or right wall is included, allow rectangularity to be established.
7. If isolated verticals exist within polyline bounds, integrate them into the table.

The results of this process are shown in Figure 4.3-9.

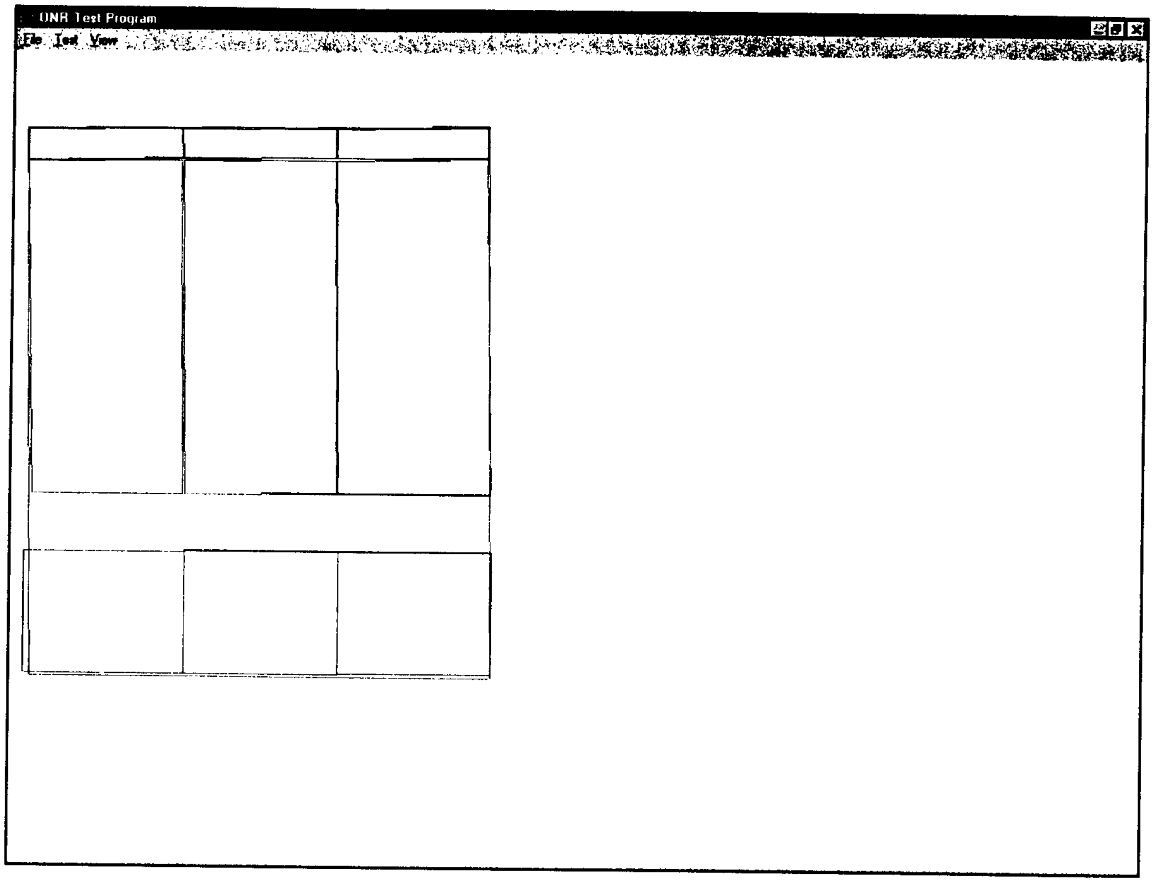

Figure 4.3-9 Results of Finding Columns for Table Shown in Figure 4.3-8

Finally, the last type of table encountered is that of no frame, with complete columns. This type has no line bounding the table on the left, bottom, or right side. It is similar to a tic-tac-toe grid. An example of this type is shown in Figure 4.3-10.

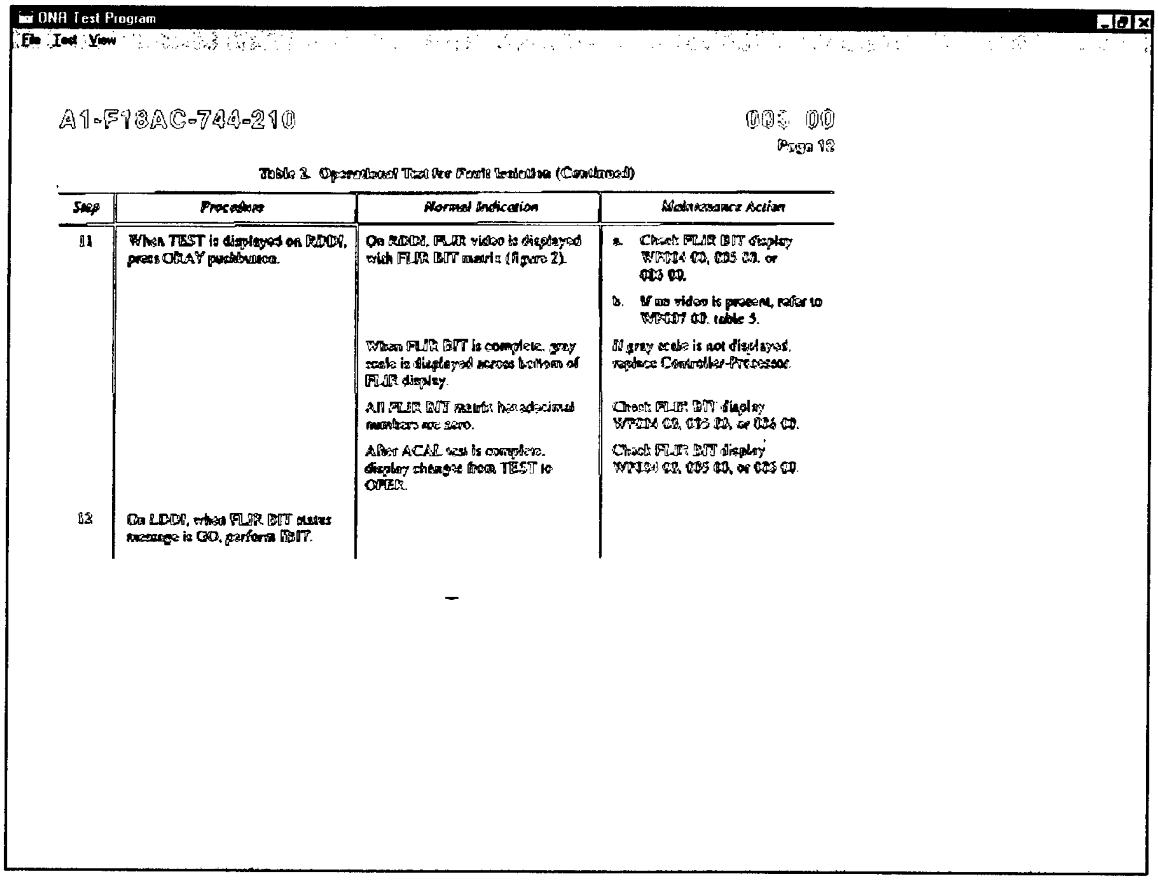

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Table 2. Operational Test for Fault Isolation (Continued)

Step	Procedure	Normal Indication	Maintenance Action
11	When TEST is displayed on RDDI, press GRAY pushbutton.	On RDDI, FLIR video is displayed with FLIR BIT matrix (figure 2).	a. Check FLIR BIT display WP004 00, 005 00, or 006 00. b. If no video is present, refer to WP007 00, table 5.
		When FLIR BIT is complete, gray scale is displayed across bottom of FLIR display.	If gray scale is not displayed, replace Controller-Processor.
		All FLIR BIT matrix hexadecimal numbers are zero.	Check FLIR BIT display WP004 00, 005 00, or 006 00.
		After ACAL test is complete, display changes from TEST to OPER.	Check FLIR BIT display WP004 00, 005 00, or 006 00.
12	On LDDI, when FLIR BIT status message is GO, perform IBIT.		

Figure 4.3-10 Table With No Frame and Complete Columns

The process identified in the last example would recognize the second and third columns in Row 1 as rectangle, and the second and third columns in Row 2 as VHV sequence open rectangles. However, this leaves the entire columns one and four unrecognized. In order to handle this, we first identify this table as unframed. This is accomplished by identifying a horizontal line left of the leftmost vertical line. If a table were framed, the leftmost vertical would obviously be a line in the frame, and there would be no horizontals to the left of this line. Once this has been established, some new horizontal-vertical line sequence searches are performed. Vertical-Vertical-Horizontal-Horizontal (VVHH), as well as Horizontal-Horizontal-Vertical-Vertical (HHVV) sequences are searched for in this case to identify the table corners, or Row 2, Columns 1 and 4. Similarly, Horizontal-Vertical-Horizontal (HVH) sequences are searched for to identify columns with unbounded left or right sides, in this case Row 1, Columns 1 and 4. The process can be summarized as follows:

1. Recognize all complete rectangles within the image.
2. Identify all verticals and horizontals.
3. Search for Vertical-Horizontal-Vertical sequences.
4. Check closure of sequences for rectangularity.
5. If closure fails, check for inclusion of the left or right table wall in the VHV sequence.

6. If left or right wall is included, allow rectangularity to be established.
7. If isolated verticals exist within the polyline bounds, integrate them into the table.
8. If a horizontal exists left of the leftmost vertical, search for VVHH, HHVV, and HVH sequences.

This process yields the results shown in Figure 4.3-11.

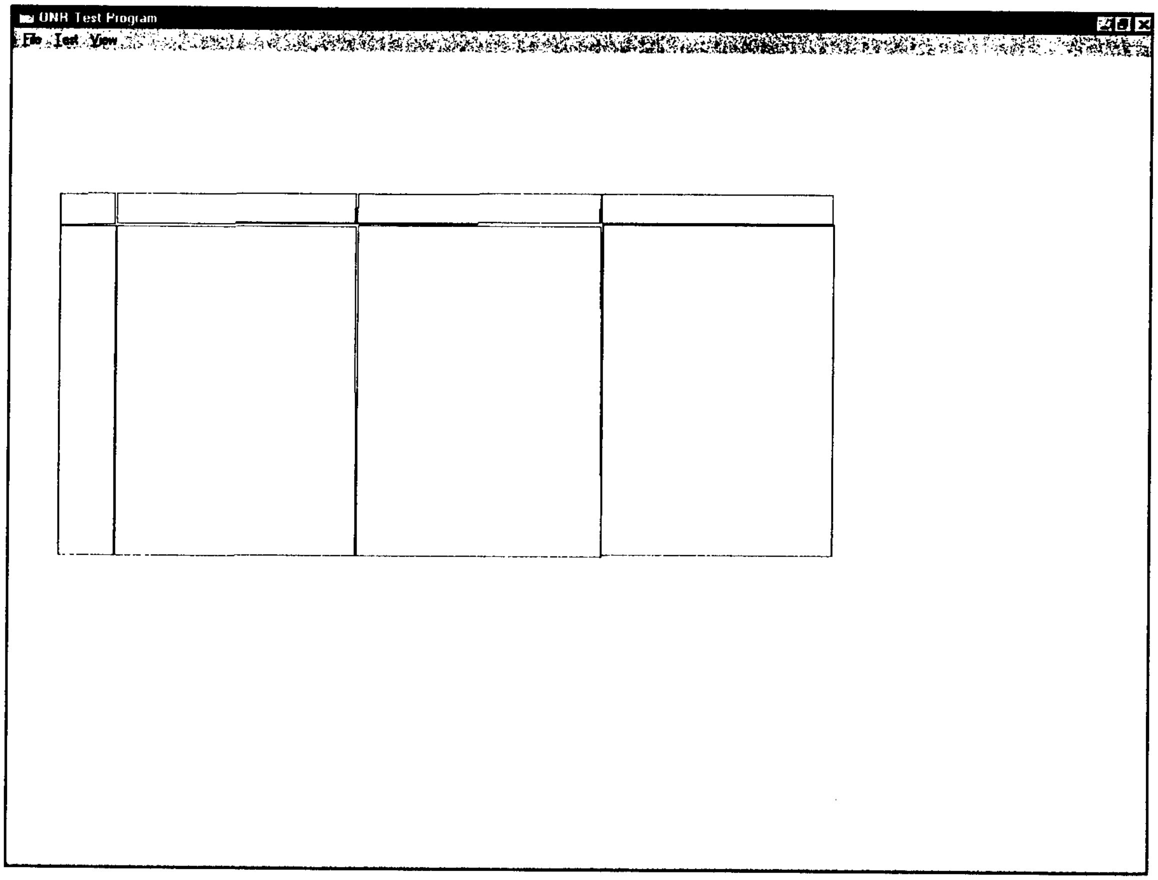

Figure 4.3-11 Results of Finding Columns for Table Shown in Figure 10

The process summarized for the last case represents the basic algorithm (in order to recognize table rows and columns) conducted on each page.

4.4 Vector Analysis in Flow Diagram Processing

Similar to tables in troubleshooting information, troubleshooting flow diagrams contain valuable information that can be gained by conducting vector analysis on the scanned image of the page. These flow diagrams are constructed of a series of boxes on a page, containing text instructions, and information on relationships between the various boxes. Vector analysis can be useful if these box regions can be identified, as well as the flow from one box to the correct next box.

Figure 4.4-1 shows a typical simple troubleshooting flow diagram, or decision tree. Examples of more complex graphical troubleshooting information exist, but the basic recognition concepts were created using the more simplified examples.

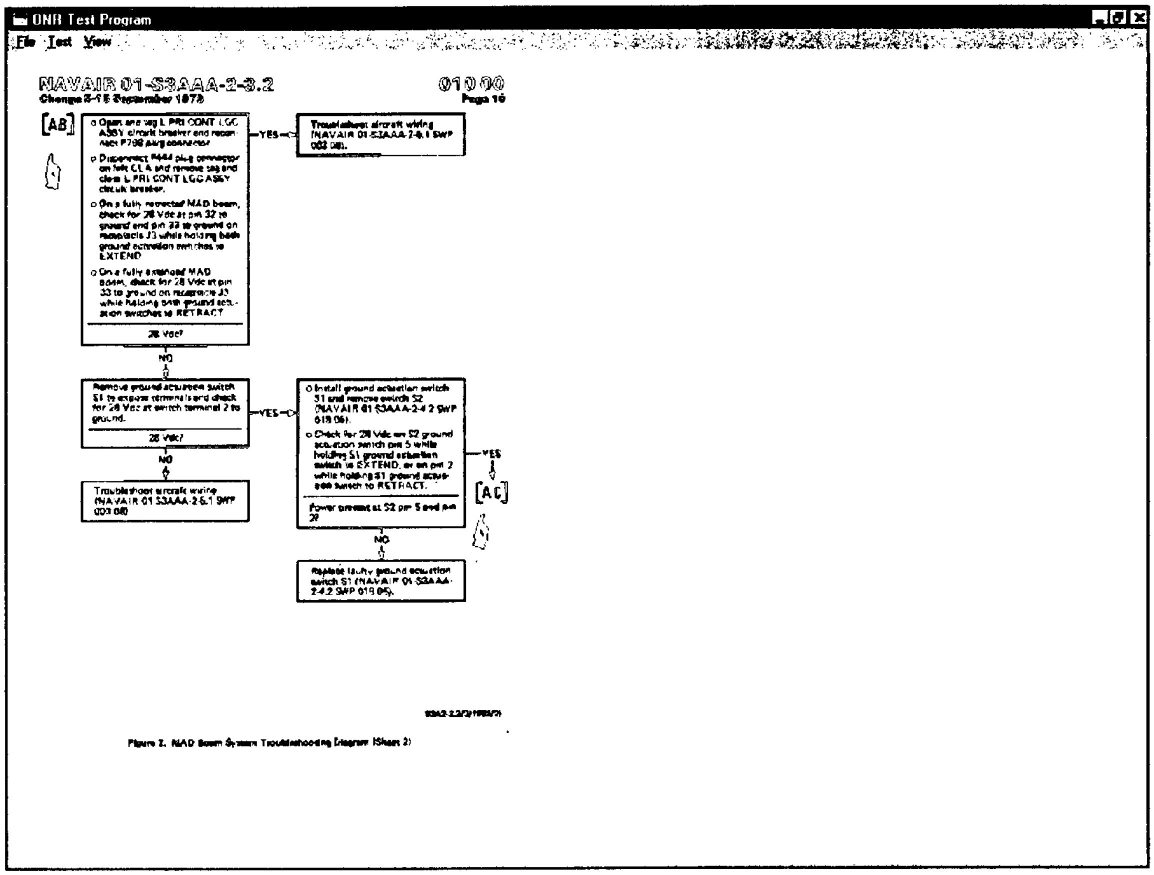

Figure 4.4-1 Typical Simple Graphical Troubleshooting Decision Tree

Figure 4.4-2 shows a zoomed-in detail of the bottom two flow boxes of the left column shown in Figure 4.4-1. This zoomed-in detail will be used to explain some of the assumptions and methods used to find the boxes and flow between the boxes in the diagram.

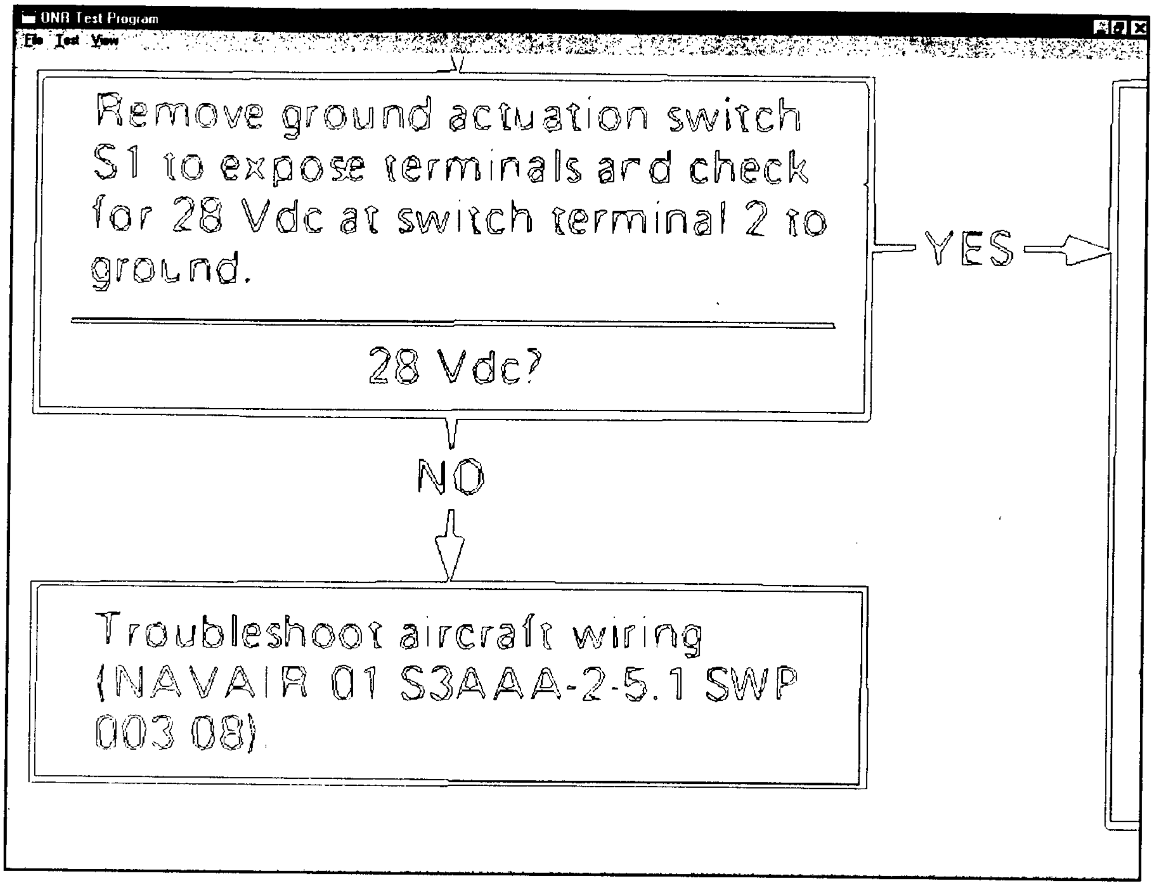

Figure 4.4-2 Detail of Troubleshooting Tree Shown in Figure 4.4-1

You can see in Figure 4.4-2 some of the basic characteristics of graphical troubleshooting information. One characteristic is that of having a complete vector shape, in this case a rectangle, surrounded by the same broken vector shape, the breaks being the entry and exit points of the information flow. The basic identification method is as follows:

1. Find the complete shapes (rectangles in this case).
2. Find the broken outer shapes.
3. Identify the breaks in the outer shapes.
4. Link the breaks in the outer shapes to breaks in other outer shapes.
5. Search for linking information contained between the breaks of links shapes.

For example, with reference to Figure 4.4-2, the two complete rectangles would first be found. That is, the inner rectangles of the two boxes. Next, the outer rectangles would be found. These two rectangles would be examined, and it would be noted that the top rectangle contains a break in the top, right, and bottom side. The bottom rectangle contains a break in the top side. Then links between breaks would be established. A right break links with a left break, a top with a bottom, a bottom with a top, and a left with a right. In the case shown in Figure 4.4-2, the top rectangle would be linked from the rectangle above it, to its top. It would link to the rectangle to its right, and to the rectangle to the bottom. These are all indirect links, because the exit line and

entry line are not the same line. They are actually different lines, linked by linking information, such as "Yes"' or "No."

So, in the case shown in Figure 4.4-2, the bottom of the top rectangle is linked with the top of the bottom rectangle, and then a search is performed for linking information. This information is just isolated polylines contained between the exit and entry points, which *may* be some sort of valuable information. These polylines have no meaning in the vector recognition process, and their validity must be determined later, when paired with OCR results.

Figure 4.4-3 shows the results of flow recognition performed on the detail shown in Figure 4.4-2.

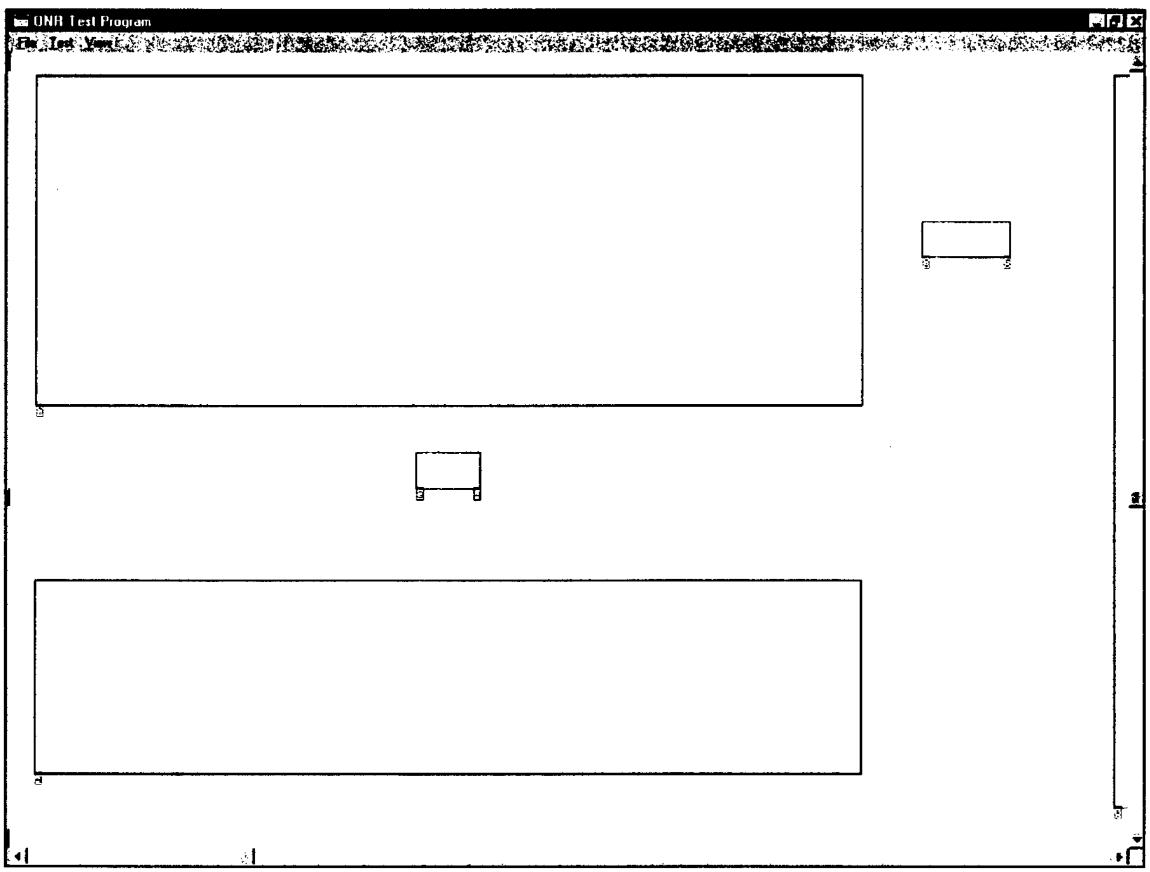

Figure 4.4-3 Results of Flow Recognition on Detail Shown in Figure 4.4-2

You can see, when comparing Figures 4.4-2 and 4.4-3 that the top rectangle, bottom rectangle, and even the right rectangle have all been recognized. Also, the flow between these rectangles has been properly identified, and the linking information has been identified. The small numbers hanging from the rectangles are identification numbers, arbitrarily assigned. The top rectangle has been assigned ID 3; the bottom, ID 4; and the right have been assigned ID 5. Figure 4.4-3 shows that the polyline making up the word "NO" has been identified as the link between rectangle 3 and 4. Likewise, the polyline making up the word "YES" has been

identified as the link between rectangles 3 and 5. A closer view of the ID numbers is shown in Figure 4.4-4.

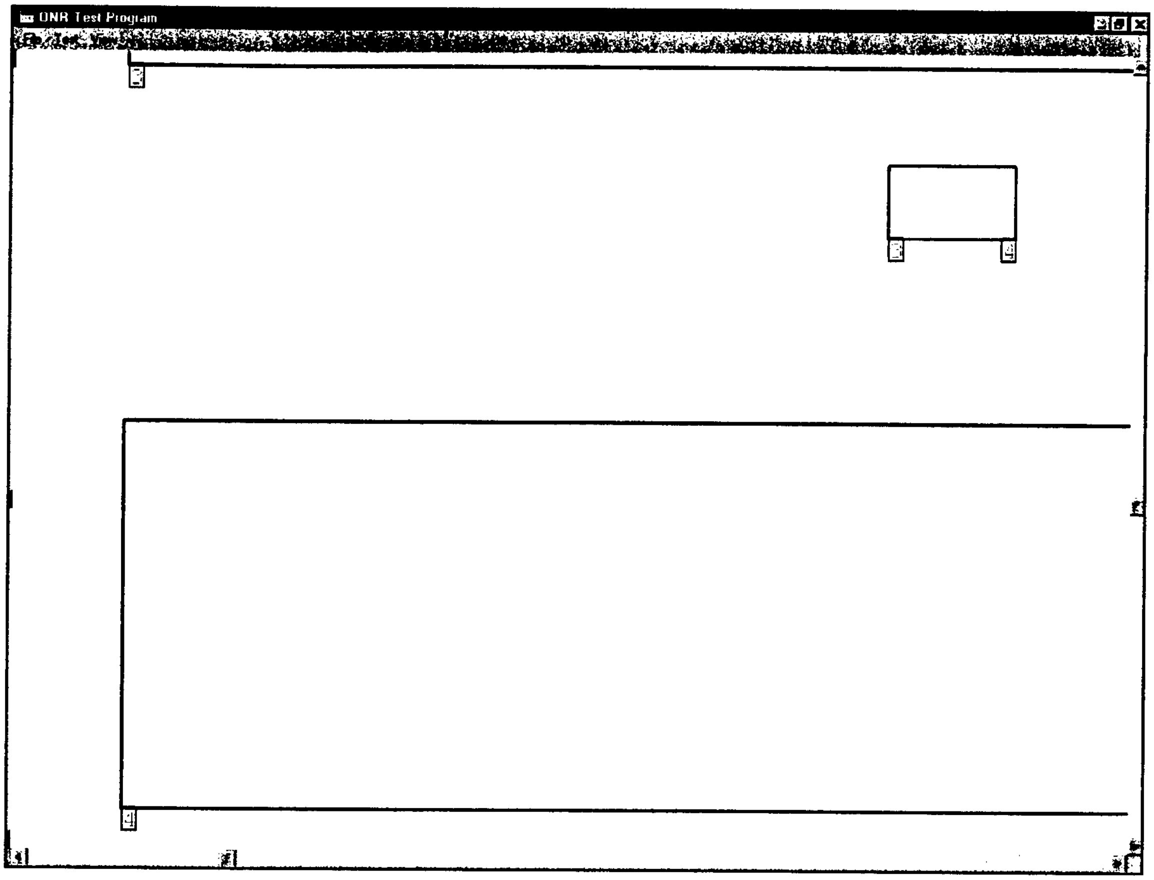

Figure 4.4-4 Detail of Identification Numbers

Then entire flow of the diagram can be captured if the starting points are identified. In this case, it was assumed that rectangles with no breaks on the top and left sides were starting blocks. However, this assumption does not always hold true in examples of more complex graphical troubleshooting information. Figure 4.4-5 shows the identification of the flow of the entire diagram shown in Figure 4.4-1.

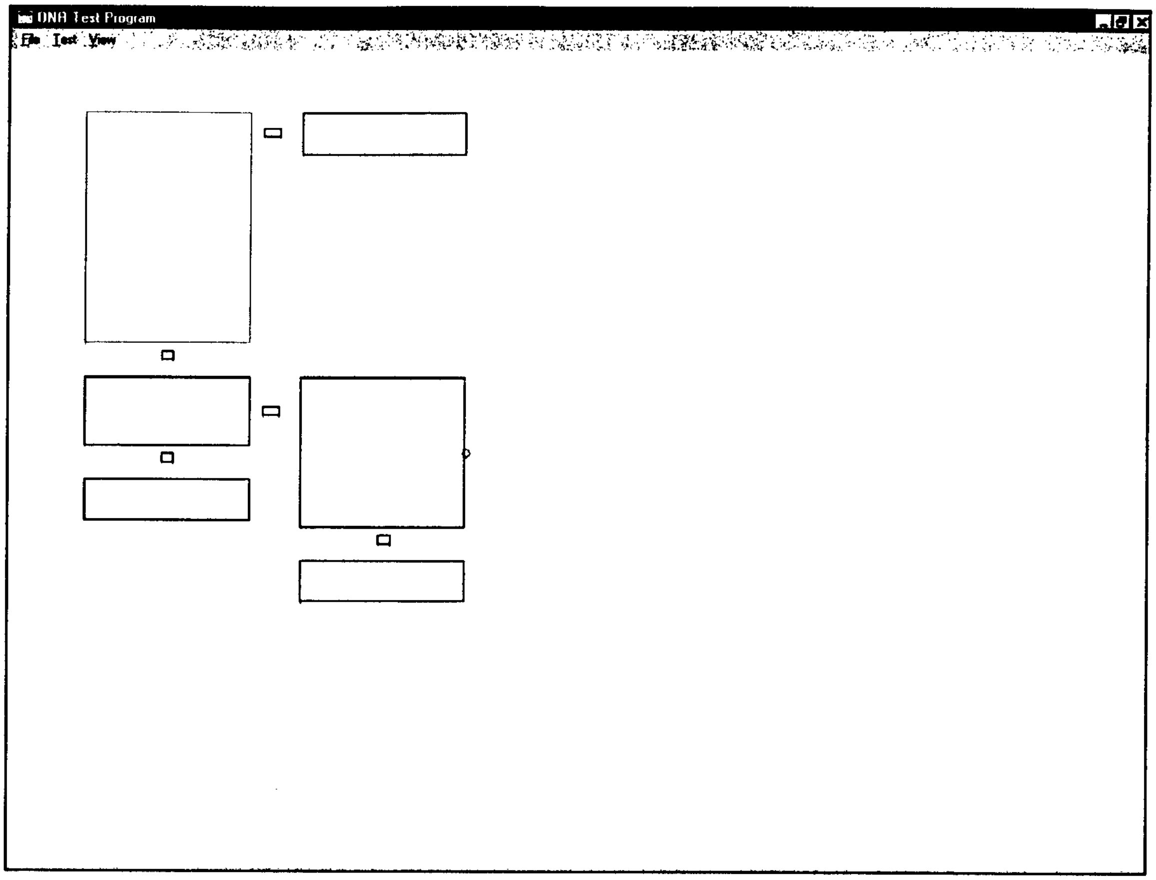

Figure 4.4-5 Results of Flow Recognition on Entire Diagram Shown in Figure 4.4-1

The small circle on the right side of the large box in the right columns denotes an unlinked exit point. This is because it links to an off-sheet reference, which presently is not handled.

4.5 Advanced Page Layout

This aspect of the ACTI project is concerned with processing text pages from the manuals. The term "text pages" refers to any page in which the content of the page is primarily textual information. These pages include regular prose text pages such as might be found in any manual (organized by sections and paragraphs), as well as pages consisting of text tables. They are distinct from other types of pages that consist mainly of graphical elements such as line drawings, flow charts, or diagrams (such as schematics). This distinction is of course somewhat artificial, as often these types of elements are mixed together on the same page. However, results from the survey conducted on the troubleshooting manuals indicate that a substantial segment of the troubleshooting information consists of text tables. This section is addressed to this subset of the manuals.

Capturing the information contained in these pages involves the identification and recognition of the text on the page; the aggregation of the text elements on the page into meaningful units; the recognition of relationships between these units, and the identification of complex structures in the document. This type of information must be captured if the information in the manual is

to be correctly understood and classified. Moreover, manual (human operator performed) decomposition of the documents would be time consuming and thus, costly. If an automated solution to this problem can found, the entire process of conversion from paper manual to 87269 database structure can be facilitated.

In the following sections, the nuances of this problem will be described, approaches to the solution of the problem will be discussed, and the method ultimately developed to solve the problem will be described in detail. While at first glance the decomposition of the document into meaningful elements seems to be a straightforward proposition, it is in fact a quite difficult problem. In fact, it is precisely because humans perform this type of recognition and analysis at a nearly subconscious level, that the problem simultaneously appears simple while in fact it is filled with subtlety and complexity. In Section 4.5, these issues will be examined in detail and possible alternative approaches to the problem will be discussed. The methodology actually chosen to address this problem will be the topic of Section 4.5.2. In this section, the proposed solution will be presented and the various software components will be explained in some detail. In the final section, 4.5-3, the future directions and goals of this research will be discussed as well as its role within the ACTI effort.

4.5.1 Issues

In this section, the precise criteria for proper document analysis will be defined and explained. Additionally, the particular subtleties and problem areas to be addressed will be presented. From this discussion will flow a set of design goals and conditions which were defined during this research, followed by a discussion of various methods of achieving robust and successful automatic recognition.

4.5.1.1 An Explanation of Page Analysis

As discussed above, the analysis of the page involves identifying primitive elements on the page, assembling the primitive elements into higher order structures, and identifying the relationships between these higher order structures. The goal of this process is to ferret out the "meaning" encoded in the layout of the page by the authors of the document. In the case of simple prose text, such as the current document, the process is relatively straightforward. The document follows a conventional hierarchical structure composed as follows:

- Sections.
- Sub-Sections.
- Paragraphs.
- Single Lines of Text.
- Individual Words.
- Individual Characters.

In this scheme, each higher level structure is composed of one or more elements from the lower order structures. This is, of course, somewhat simplified as we are ignoring such features as embedded pictures and diagrams, headings and numbering of sections, and features such as the

bulleted list above. However, it serves to illustrate this process at a rudimentary level. Proper analysis of this document would involve parsing out the sections and subsections, and the paragraphs that make them up. Note that in this scheme there are no references to pages in the logical structure of the document – because, in fact, the pages are artifacts of the actual physical presentation of the document, not its structure. Hence, in this scheme, paragraphs that span from the bottom of one page to the top of another should properly be merged together as one logical unit. This analysis would allow the document to be converted to another format, such as an HTML document, or stored as descriptive text in an 87269 database.

Unfortunately, this example is much simplified from the world of textual variety that is encountered in a typical troubleshooting manual. The manuals present information in a variety of formats, utilizing a complex range of styles and devices to convey meaning. Some of the features routinely encountered in some manuals that must be identified include:

- Multi-column text.
- Tables.
- Notes, Cautions, and Warnings embedded anywhere in the document.
- Hierarchical relationships expressed through indenture.
- Sequences denoted using tags on lines or paragraphs of text.
- Structures (Tables, Paragraphs, Notes, etc.) that span across multiple pages.

All of these features (and many more) must be recognized and handled correctly by an automated system that hopes to parse the meaning from a document.

The principle difficulty with this problem is the fact that the documents were produced by human beings for the consumption of other humans who share a common understanding of how documents are laid out and what particular features "mean." This common understanding is, in effect, almost subconscious and this is the source of the difficulty in designing an automated system to solve this problem. The "rules" and conventions of laying out documents have evolved over time to the point that they are, in effect, a sort of "grammar." However, the driving force behind this evolution was their utility in conveying information to other people - hence, it is offered here that the only system known to be very good at understanding documents is, in fact, a person. If this process is to be automated, a system must be designed that can mimic those features of the human mind which allow it to perform this almost subconscious act of understanding.

In order to make these concepts a bit more concrete; several sample pages from actual manuals will be used. In the first example, Figure 4.5.1.1-1, a partial breakdown of the various types of information contained on the page follows (working generally from top to bottom of the page):

- Manual, work package, and page information make up the top of the page. That this information is common across the particular manual in this location is information that can be gleaned from processing multiple pages at one time.
- The table title is the next item on the page. The word "(Continued)" provides a clue that this table is continued from a previous page (there are other clues elsewhere on the page).

- The next relevant item on the page is the partially boxed body of the table itself. It indicates a table is present on the page consisting of three columns. The column delimiting lines are broken, indicating that the table contains an interruption of some kind. In this case, a Caution and a Note.
- Column headings are set off from the rest of the page by being completely boxed in (Procedure, Normal Indication, and Remedy for Abnormal Indication). The column headings are set in a bold typeface to set them off from the other text on the page.
- The word "CAUTION" appears set inside a graphical highlight box. It is also set in bold typeface and is all capitalized. It is centered above a paragraph of text, indicating that the paragraph is subordinate to it.
- A Note appears next. Again the word "NOTE" is typographically distinct and set in a particular relationship to the text comprising its body.
- Below this, the actual body of the table commences. It is composed of paragraph-like structures that are labeled with sequence tags ("ac." "ad." etc.) These tags begin in mid-sequence, indicating that the table began on another page. Note that the first 4 rows of the table are missing any values for the second and third columns.
- The fifth row ("ag.") contains elements in all columns across the table. An additional complication is that there are multiple "paragraphs" in the second and third cells.
- In the second cell of the fifth row, there is another set of sequence tags ("1." "2.") that provide the crucial clue for how to match up the paragraphs in column three with those in column two.
- The final row ("ai.") also contains a sequence indicator in the second column, providing a clue that this row in fact continues on the next page.
- There is no horizontal line closing of the table at the bottom of the page. This can be taken as another indication that the table continues on to the next page.

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Table 1. Pitot Static System and Related Instruments Leak and Functional Test (Continued)

CAUTION

To prevent damage to pitot static instruments, do not move or adjust pitot static adapter (6), open any pitot static drain, or loosen any connection/fitting in pitot static system while system is under test.

NOTE

If only leak test must be done, do steps ac thru ap and steps at thru bh. If functional test must be done, do steps ac thru bh.

Procedure	Normal Indication	Remedy for Abnormal Indication
ac. On test set (13), set ALTITUDE COMMAND FEET control to field elevation plus 5000 feet.		
ad. On test set (13), set AIRSPEED COMMAND KNOTS control to 350.		
ae. On test set (13), allow AIRSPEED COMMAND KNOTS and ALTITUDE COMMAND FEET indicators to stabilize for approximately 10 seconds.		
af. On test set (13), set STATIC PRESSURE VENT valve to closed (fully clockwise).		
ag. Set GO switch to GO.	1. NORMAL OPERATE and NORMAL lights come on.	Make sure test set is good (T.O. 33D7-3-60-71).
	2. RESET light goes out.	Make sure test set is good (T.O. 33D7-3-60-71).
ah. Set GO switch to GO.	ALTITUDE and AIRSPEED MONITORED displays slew to commanded values.	Make sure test set is good (T.O. 33D7-3-60-71).
ai. Wait 5 minutes then set LEAK TEST - ALT and A/S switches to ON.	1. LEAK TEST ALT and A/S indicator lights come on.	Make sure test set is good (T.O. 33D7-3-60-71).

Figure 4.5.1.1-1 Sample Manual Page

The preceding list, although tedious, is provided to illustrate for the reader the types of information that it is necessary to extract from the page to perform an adequate decomposition. The placement of the text on the page, its relation to other page elements, the actual content or

meaning of the text, extra-textual elements such as lines or special symbols on the page - all these elements must be recognized and understood in their totality.

One particular feature was hand-waved completely in the above list but is perhaps the most critical of all. The assumption was made above in the first few items that there was a table on the page. From this assumption flowed a lot of the following decomposition such as the formation of the rows and columns of the table. How in fact can the recognition of the table be done by an automated system? This particular page has several distinct clues:

- The word "table" appears in a label position.
- The lines on the page delineate three columns.
- The text on the page is (mostly - consider the Caution and Note) oriented around these columns.
- There are column headings at the top of the three columns.

More subtle clues include the fact that there are distinct break points between the rows that extend across the page. If one attempted to interpret the page as a series of paragraphs that are displayed in a three-column format, there are substantial gaps in the text (in columns two and three). All of these factors point to the fact that there is a table on the page (which in fact there is). However, it is important to realize that no one indicator is decisive, either in a positive sense or in a negative one. That is to say, any of these factors could be absent and the remaining indicators would constitute sufficient evidence that there was a table present. There could be many pages that contained some of these features that did not have tables on them.

The very difficulty of nailing down what defines a table is at the heart of this entire process. The very structures that the process is supposed to identify in a document are in fact very slippery concepts indeed. In fact for many problems of categorization in these manuals, the correct answer is often "what a person looking at the page would think," rather than any hard and fast rule. For almost any conceivable set of rigid rules one can define, the exception is always just around the corner (or in this case, on the next page). If this process is to be automated, the system designed will have to be capable of handling this variety of circumstances and conditions with a tremendous amount of flexibility and robustness.

4.5.1.2 Challenges in Automated Page Analysis

The very "fuzzy" nature of the definition of the structures used in the documents (as in the example of the table in the previous section) is one of several challenges to developing a comprehensive, automated solution to this problem. Some of the more straightforward problems are outlined below:

- **Structures that span across pages -** This problem requires adaptation of algorithms to span pages and make connection across them. This adds to the complexity of the software and places additional strain on hardware resources compared to processing individual pages.

- **Unreliability of automated OCR** - Present OCR technology cannot deliver 100% accuracy even under the best of circumstances. Even extremely low error rates could wreak havoc with a system that is attempting to use the OCR results in further processing, unless steps are taken to account for the possible presence of these errors. Building this type of tolerance for errors in the system adds complexity.
- **Unreliability of other image processing primitives** - All the image processing processes used to find primitives on the page such as blob analysis, vectorization, symbol recognition, and text segmentation produce data that cannot be guaranteed to be accurate.
- **Wide variety of potential structures and forms that must be handled** - The sheer number of different types of structures adds significant complexity to the system. For instance, within a single manual, five different conventions were found for indicating an ordered sequence.

All of these problems need to be dealt with and accounted for if an automated solution to this problem is to be found.

A more subtle factor is the resistance of this problem to a strictly "bottom up" approach. By "bottom up" approach, it is supposed that the system starts with an initial set of primitives and then assembles higher level structures from them. These higher level structures form the primitives for successive steps until the highest level structures are built. For example, in Section 4.5.1.1, the example of a simplified document such as this report was used. To apply the strictly "bottom up" approach, the initial primitives would have been characters, which would be assembled into words, which would be assembled into lines of text, which would be grouped into paragraphs, and so on, until the document itself was assembled. In this simple example, the approach would seemingly work fine. In a more complex document, containing a richer structure, such as the technical manuals being considered here, this approach will likely fail. This can be illustrated in the example of the table used above. In describing the problem initially, the presence of the table was just assumed at one point, in a manner that is not possible in an automated system. There must be some definite point at which the presence of the table is detected - and, (this is the crux of the issue) once detected, this must influence the future direction of the processing. When dealing with complex structures such as tables, it is not always possible to design recognition algorithms that proceed strictly from the bottom up.

WP Number	Title
001 00	Alphabetical Index
001 01	Work Package Index
002 00	Introduction
003 00	Pitot Static System and Related Instruments -Testing
003 01	Pitot Static System and Related Instruments-Test Set TTU-205C/E
003 02	Pitot Static System and Related Instruments-Test Set TTU-205D
003 03	Pitot Static System and Related Instruments-Pitot Static System Heaters Test

Figure 4.5.1.2-1 Example Table

Figure 4.5.1.2-1 illustrates this point. A strict "bottom up" method would almost certainly build the text in the right column into a multi-line chunk of text or paragraph. Any reasonable method would likely group the bottom seven lines in that column into one coherent chunk. This is plainly wrong, but this fact is only apparent when one is able to discern the fact that the entire image makes up a two-column table. However, this type of insight is only available to systems that allow the creation of both "bottom up" and "top down" pressures to be accommodated. This is a quite simple example, but the sample data that has been examined so far is rife with examples of this type that militate against the usefulness of strictly "bottom up" approach.

To belabor a somewhat obvious point, a strict "top down" approach cannot be implemented either, without requiring the human operator to classify large-scale structures in the document manually. While this is a possibility, at present it appears to be a worthier goal, in terms of potential payoff, to work towards a more automated solution.

4.5.1.3 Design Goals

The overall goal of this work was to develop a methodology that could be used to solve this page decomposition problem in the most general case. To focus the work more closely to the immediate needs of the ACTI system, a subset of the overall problem was chosen. This subset will consist of the two most predominant types of troubleshooting tables encountered in the manuals that were surveyed:

- The "Procedure/Yes/No" type of tables.
- The "Procedure/Normal Indication/Remedy for Abnormal Indication" type of tables.

In addition to their ubiquity, these two types of tables have other features that recommended them for this work. They contain sequences, indentures, compound cells, embedded notes and cautions, and many of the other complex features that make this type of work so difficult. Secondly, it is excellent proof of the value of this type of processing, as the tables map very closely to 87269 structures. Hence, if they can be properly parsed in an automated fashion, it should not require multiple levels of human intervention to insert them properly into the database. Lastly, working simultaneously on two different types of tables will force the method developed away from being too tailored to a specific set of circumstances and should thus insure that it is more general.

Some further assumptions and decisions that guide this development are listed below:

- The process, at this stage, should be automatic and require no human intervention. The input to the system will simply be scanned document pages representing a coherent piece of a manual (work package, chapter, etc.).
- There should be no assumption of accuracy from any of the image processing subsystem utilized by the process. For example, it will not be assumed that the OCR has undergone human quality assurance. The system must cope with missing, incomplete, or possibly wrong data.

Building on the issues discussed above, a set of design goals was created to guide the development of a solution to this problem. These are outlined in the following list of features desired in the prototype system:

- **Incorporation of the widest amount of data possible** - The system should attempt to use a variety of input data, in an attempt to overwhelm the limitations of any particular method.
- **Capable of handling missing, incomplete, or incorrect data** - The system should make no assumptions about the correctness of the data that it acquires. This should extend to features such as loosening matching constraints in cases where other pressure warrants it.
- **Support for both bottom up and "top down" pressures** - The system should include provisions for developing its own "top down" pressures based on what it finds in a particular problem, rather than just proceeding in a bottom up fashion.

- **Robustness in the presence of unfamiliar data** - The system, when faced with intractable problems, should "fail gracefully." That is, it should not just collapse completely, but should attempt to handle the parts of the problem it can and thus, return at least "partial answers."
- **Homogenous handling of data from different sources** - The system should attempt to use all available sources of data during different phases of the processing, thus the data should be represented in common format, whatever its source. The data structures that support the processing should be flexible enough to handle the introduction of new types of data without substantial revision, and it should be possible to make these changes without massive amounts of re-coding.
- **Support for prototyping activity** - The system should be designed to provide a clear view of its internal functions to the developer. It should also be designed with the maximum amount of flexibility available.
- **Self-monitoring ability** - The system should have the ability to abandon particular paths of exploration if they prove to be dead-ends, exchanging them for more fruitful ones.

To a large degree the goals interact to form one large overarching goal which can be best summed up as:

The system should operate with the same degree of robustness and flexibility that organic systems display. Realistically, this goal must be taken with a grain a salt, although it forms a worthy direction in which to head.

With these goals in mind, a variety of potential methodologies were considered and rejected. These are listed below, along with brief summaries of why they were rejected:

- **Procedural Program** - This approach could not possibly yield the type of flexibility needed.
- **Rule-Based Expert System** - This type of "perception/cognition" problem is typical of the sort of problem that first tripped up traditional Artificial Intelligence (AI) research.
- **Fuzzy Logic System** - This type of system offers some of the flexibility that is needed but still fundamentally involves a linear, "bottom up" process. Some elements of the adopted methodology resemble fuzzy logic constructs.
- **Neural Network** - Despite their successes in some perceptual areas that other more traditional AI methods failed miserably at, this problem holds too much complexity for this type of approach. However, nothing precludes using neural nets as an adjunct methodology in the current design.
- **GCS Type System** - This methodology, developed by ManTech in support of the Carderock GCS effort, utilized various overlapping image processing techniques incorporated in a voting scheme. This method achieved excellent results in overcoming the flaws of particular methods to create a robust recognition system. However, it lacks the interaction between components that will be necessary to recognize and build the more complex structures that exist in this problem area.

4.5.2 Approach

The approach currently being developed at ManTech owes its inspiration to two pioneering AI research efforts. The first of these is the HearSay speech recognition project carried out at Carnegie-Mellon University in the 1970's. This project pioneered the use of blackboard architecture and the concept of using processes simultaneously working at different levels of a problem in concert. It represented the first attempt to create a programming environment in which "top down" and "bottom up" pressures could coexist. The second inspiration comes from the work of the Fluid Analogies Research Group at Indiana University. This group, under the leadership of Douglas Hofstadter, has developed a distributed, probabilistic model of certain aspects of human thought. Much of the terminology in this section of the report derives from their work, although the effort here differs in many significant ways.

The approach being developed is referred to as a Parallel Terraced Scan (terminology from Hofstadter). The method consists of a simulated distributed processing environment in which small, autonomous pieces of code run stochastically. These pieces of code (codelets, again from Hofstadter) are executed according to a dynamically variable probability function. As they run, they interact with data structures held in a common pool (known as the Workspace, again from Hofstadter), reading the data held there, creating new items of data or destroying existing items. Each codelet is designed to do a simple, automated task such as joining two adjacent lines of text together into a larger structure. Additionally, based on the results of their action, the codelets can dynamically adjust the probability distribution of the codelets that will run in the future. The goal is that at the macro level, the system will display intelligent behavior as a statistically emergent function of this entire low-level behavior. A fitting analogy is that of an ant colony, in which the macro effect of much random seeming activity by individual ants leads to the construction of a complex anthill, far beyond the awareness of any ant and without a centralized plan.

The Parallel Terraced Scan addresses the design goals established above in a unique and thorough fashion. The name itself implies the exploration of multiple solutions to the problem at hand. The system is designed such that, over time, it can adapt itself to the particular features of the problem at hand. Alternate hypotheses can be constructed and explored, and if necessary abandoned. The principle drawback to the method is that nothing like this has been attempted on a problem of this complexity before; however, given the drawbacks associated with the other methods considered, it looks like a promising research area to pursue.

The following section describes the individual components of the system, and how they have been tailored to the target problem. Then, in Section 4.5.3, the status of the project will be described as well as the future plans for integrating this technology into the ACTI system.

4.5.2.1 Preprocessing

The goal of the preprocessing system is to create the initial population of primitive elements that constitute the Workspace prior to the commencement of the actual processing. Existing

ManTech image-processing capabilities have been leveraged wherever possible and flexibility has been built into the system to accommodate future developments. A further goal of this stage is to insure that every item on the page is accounted for, even if it is of an unknown type.

The preprocessing module is the interface to the "conventional" image processing subsystems. At this time, these consist entirely of a series of steps performed prior to the start of processing. These steps create the initial population of data (the primitives) that exist in the Workspace at the start of the run. It is envisioned that in the future, some of the codelets may in fact invoke some of the image processing subsystems directly, providing a more interactive climate. However, at present this is not being done - all the interfacing to these routines is done up front in a procedural manner.

Currently the system interacts with the following systems:

- Text Segmentation.
- OCR.
- Vectorization.
- Blob Analysis.

Text segmentation (which uses blob analysis) is called on to create candidate areas of the image for OCR to process. The text areas are deleted from a working copy of the image. OCR is then called and the results are loaded into the Workspace as primitive characters and words. Next, the vectorization module is called to locate horizontal and vertical lines on the page. These results are also added to the Workspace as primitives and deleted from the working copy of the image. Next, the working copy of the image is fed to blob analysis that will identify any remaining objects on the image. These are added to the Workspace, presently as unidentified objects that are ignored in future processing. As the pages that are currently being processed do not have large graphic regions on them, these remaining objects should consist of small symbols or text that was not correctly classified.

Future enhancements to this system are planned. An effort is currently underway to create a stand alone symbol recognition capability utilizing the existing GCS technology. When this is in place, the unclassified items from the pages described in the above paragraph will be fed to this sub-system for recognition. The vector based table recognition described elsewhere in this document will be incorporated, as well as other capabilities that are developed in the future.

4.5.2.2 Workspace

The Workspace is the blackboard of the system in which all data is kept and made globally accessible to the other components. The principle design goals in the construction of the Workspace were flexibility (because it must contain all data currently in the system and types of data which may be added in the future) and simplicity (to simplify the interaction of the other components with it). Because of the need for great power and simplicity, much care has gone into the design of the Workspace. The Workspace is in fact two concepts. The first is the actual data structures which exist within the program while it is running and the second is the

"grammar" of allowable constructs in the Workspace. The first is, essentially, the actual physical manifestation as it exists in the computer's memory while the program is running, and the second is the logical structure of the items which can be built within it.

Because of the need to be both powerful and flexible, the simplest possible implementation was chosen for the Workspace. (The inspiration for the data structures came from the programming language LISP.) Everything in the Workspace is called an "item" and is represented in a homogenous way. Items consist of three features:

- a type, that identifies what they are
- a pointer to another item, which allows groups of items to be assembled
- an attribute pointer, that is a pointer to a list of other items which describe this item

Certain items are known as terminals. Terminal items are those that have specific pieces of data associated with them. All item types are either attributes or peer items. Attribute items can only appear in the attribute list of another item. (Most terminals are attribute items.) All data stored in the system is in this format. The scheme accommodates all the actual data structures stored in the Workspace. There are other bookkeeping issues that can be ignored here, such as keeping track of the items in the Workspace, how they are retrieved when needed, their creation and destruction, etc.

The other aspect of the Workspace is the logical structure. This is analogous to the grammar of a programming language. This grammar defines what combinations of structures can be created in the Workspace. In effect, it describes what item types can have what attribute types. This grammar has two distinct dialects or flavors. In the "loose" form it governs what types of structures can be created in the Workspace during a run of the program. In the "tight" form, the grammar is more restrictive about what kinds of structures are allowed. The tight form of the grammar represents the constraints that must be in effect when the program has stopped running. In the tight form of the grammar, these restrictions limit the types of potential output to those that can be usefully passed on to other parts of the system. The simplest example of a difference between the loose and tight grammar is the concept of the "parent" relationship. In the loose grammar, an item can have multiple parents. This allows the system to experiment with different ways to assemble items in the Workspace simultaneously. In the tight grammar, which must be observed at the end of processing, each item can only have one parent. This creates a pressure in the system to resolve items with multiple parentage during processing.

The Workspace can best be explained with a simple example. Consider the following sentence:

Open the door.

In the Workspace, this line of text would be stored as a TEXTLINE item with the following attributes:

- LOCATION - this attribute is a terminal that gives a bounding box for the item and its parent page.
- FONT - this attribute is a terminal that would contain information about the typeface, point size, and other features of the font.
- LIST - this attribute is a non-terminal that denotes that a list of other items makes up this item. Its attribute pointer points to a list of LISTMEMBER items that in turn point to the WORD items that represent the individual words in the TEXTLINE.

These WORD items would have the same list of attributes as above, with the addition of a PARENT item which would point back to the original TEXTLINE item. The LIST attribute for each word (:"Open," "the," and "door") contains LISTMEMBER items that point to CHARACTER items which would feature LOCATION and FONT attributes, as well as an ASCII attribute (a terminal containing the ASCII representation of the letter) and a PARENT attribute pointing to the parent WORD item. In similar fashion the entire TEXTLINE could be incorporated into a MULTILINETEXT item as a member of its list.

In the present implementation the Workspace is held entirely in memory as a compound structure consisting of a network of nested linked lists. A substantial amount of code has been created to support the access requirements of the codelets. Due to the homogenous nature of the structures, they would adapt quite readily to being stored in a database during processing rather than being held entirely in main memory. The immediate disadvantage of this scheme would be speed. However it is unclear at this time how much of an issue this might be. The immediate advantage of storing the Workspace data in a database would be ease in experimenting with different types of access methods for the codelets. This concept has not been explored at present.

4.5.2.3 Codelets & Coderack

The codelets are the active elements of the system, while the coderack is the data structure that determines which codelet is to run next. As described above, the codelets are small pieces of code that implement a single action, such as joining words into a text line or noticing a particular feature. They operate on items in the Workspace, utilizing the data that is found there to make decisions and posting their results to the Workspace in terms of adding or deleting items. The only other direct action they can take is to alter the probability distribution on the coderack, thereby influencing the future direction of the system. As processing is carried out, the cumulative action of these codelets create structures in the Workspace that represent the system's "view" or solution to the problem being solved.

All codelets follow the same basic pattern of action. This consists of three distinct phases: **observation, decision,** and **action**. In the **observation** phase, the codelet selects one or more items from the Workspace according to certain criteria. This can be a relatively simple action, such as randomly selecting an item of a specific type, or more complex such as selecting an item

that has specific attributes. It can also involve selecting multiple items where the choice of the later items is determined by the previous item selected. This would be the case in a codelet attempting to build multi-line structures (such as paragraphs) from TEXTLINE items. Such a codelet would select a starting TEXTLINE item more or less at random and then look for items nearby to pair it up with. In the second -phase, **decision,** the codelet makes a judgment about the items that it has already selected by measuring it against its internal criteria. Again, these criteria run the gamut from the extremely simple to the very complex. In most cases, this judgment consists of applying specific tests to the item or items being considered and generating a resulting numerical score, which is then used to make a pass/fail decision. In the third phase, **action**, the decision is implemented by making changes to the Workspace, which can consist of adding, deleting, or changing items. In most cases, the codelet also will adjust the coderack based on the result of its **decision** phase. These adjustments consist of adjusting the probability of various codelets running in the future.

The coderack is simply a data structure that maintains the current probability distribution of the codelets in the system. Each codelet is represented in the coderack by a number ranging from 0 to 100. This number is referred to as the codelet's density. In the simplest case, a particular codelet's density number divided by the sum of the densities of all codelets in the system provides the probability that a particular codelet will run. As described above, codelets that run can adjust these densities up or down and thereby influence the probability distribution. The coderack actually functions in a slightly more complex manner than this, in that two additional factors influence the probability distribution. The first of these is an aging factor that is used to insure that low probability codelets are not completely shut out from running. This feature increases the odds of a given codelet running the longer it has gone with out being activated, without altering its density on the coderack. The second feature is the influence of the "temperature" factor, which is discussed in depth in the next section.

The codelets in the system can be divided into roughly four distinct types:

- **Scouts** - This class of codelet looks for particular features or relationships among the items in the Workspace. When these features are found, attribute items are created and attached to appropriate items. Examples of the types of features include keywords such as "Page" or "Note" indentures, certain characters that denote relationships such as hyphens or colons, etc.
- **Structure Builders** - This class of codelets looks for patterns or relationships between items in the Workspace and attempts to build higher level structures. Examples of the types of structures are text lines, multi-line text chunks (paragraphs), table rows, sequences, etc.
- **Structure Evaluators** - This class of codelets looks at the structures in the Workspace and evaluates them in terms of criteria such as strength and consistency. Based on the evaluations, they can destroy existing structures or attempt to resolve conflicts between competing structures.
- **Control** - This is a "catch all" category for codelets that do not fit the other classes. The codelets perform actions related to the global state of the system such as adjusting parameters such as the temperature or determining when to cease processing.

The interaction between the probability distribution of codelets on the coderack and the structures in the Workspace define the system's ability to understand and adapt to a problem. The Workspace represents the attempts to build structures (hypotheses) about the problem being worked and, in effect, functions as a primitive "memory." The codelets and their distribution in the coderack represent directions of inquiry, trends, and tendencies that have arisen as the problem has been worked. To illustrate how this actually works in practice, the example of the table from Section 4.5 will be used yet again. The critical issue discussed there was how to create the "top down" pressure that should result from the presence of the table while working from the "bottom up," without the foreknowledge that there is a table present on the page. In this system, as particular clues to the presence of a table are found (the word "Table," the columns delimited on the page, the text arranged in columns, etc.), the codelets that find them will increase the densities of the table recognizing codelet making it more likely to run. When it does finally run, if it succeeds in establishing that there may be a table present, it will activate codelets to find the features that correspond to a table, such as column headings, rows, etc. In this way, the "bottom up" pressure forces the table codelet to run and when this happens, it then creates "top down" pressures that help solve the problem. This is a simplification of the system, but it illustrates the general principle involved that allows the program to work a problem from "both ends" as opposed to in one direction only.

4.5.2.4 Control Features

In addition to the Workspace and coderack, there are other components of the system that are critical to the processing. These components are more global in nature than the coderack and the Workspace, affecting the actions of components across the entire system. As such, they are being dealt with in a separate section. These components also share the common aim of providing feedback and damping mechanisms to the rest of the system.

The first of these is the concept of "temperature," which was briefly mentioned above in the discussion of the coderack. Temperature, as used here, is roughly analogous to the physical concept of temperature or entropy. It is a general measure of the degree of order in the system and as such is used as measure of the degree of "satisfaction" with the current state of the system. Measurement of this parameter is based on two broad concepts. The first of these is the relative complexity of the structures in the Workspace. This complexity is measured by the types of structures present (higher order structures such as tables depress the temperature) and the level of nesting of structures. The degree to which the Workspace conforms to the tight grammar also figures into this factor. The second criterion is the degree of conflict present between structures in the Workplace (referred to as "friction"). An example of this type of friction is an item with multiple parents. The presence of this type of structure represents two (or more) competing views of a particular item that must be resolved. At present, the methods of measuring the temperature are the subject of experimentation.

The temperature affects the system in several ways. As it is a measure of the system's relative satisfaction, it is used as a feedback mechanism to affect a variety of processes. In general, the higher the temperature, the farther the system is from a solution. In this case, the temperature is

allowed to influence the system to behave in a more random way. In the opposite case, as the temperature falls, the closer the system is to a solution and, hence, the less randomly the system will behave. This has an equivalent in human behavior. If someone believes they are close to success, they will tend to adopt a more conservative approach, while if they are in a situation that does not look promising, the more likely they are to take chances. The temperature directly impacts the operation of the coderack and operation of certain codelets to manifest these effects. In the case of the coderack, the temperature is used as a damping mechanism on the existing probability distribution of the codelets. In this case, the higher the temperature, the more random the selection of codelets. The other use of the temperature is by the structure evaluating codelets. The temperature is used as one of the criteria to determine whether to destroy a structure. The result is that as the temperature rises, it becomes more likely that structures will be destroyed. In these two cases, the temperature provides a mechanism to allow global conditions to serve as feedback to local decisions. In addition to these two cases, the temperature is currently one of the main input factors to the control codelets that determine when the system should cease processing. As the temperature is a measure of satisfaction, and as it is minimized, the system should be near to a solution. The whole termination process and what factors need to be considered in the decision is still the subject of experimentation.

The second global controlling component of the system consists of the set of functions that support the ability of the codelets to choose random items from the Workspace. In the current design, it has become apparent that some mechanism needed to be created to insure that the system proceeds in a more systematic way through the document (down the page, and across the pages in order). However, it was deemed important to preserve some elements of random selection in this process. The solution found was the concept of the "locus" which is an actual physical point on the page that represents the current focus of attention of the system. When it is necessary to make a random selection from a group of items in the Workspace, the distribution is skewed so that those closest to the locus are more likely to be chosen. The locus continually adjusts its position, in effect being a kind of running average position of the items most recently selected. There are additional factors at work here as well, such as a mechanism similar to the aging mechanism used by the coderack that insures that items in the Workspace are not passed by and never selected. In operation, the locus moves along the page in the general direction of normal reading order. In this way, it focuses the system and reduces the tendency to hop frantically all over the page.

4.5.2.5 Other Components

In addition to the formal components of the system described in the above sections, there are several other software subsystems that are being designed and built. Broadly, they can be broken into two categories: those implemented to provide a reusable code base to support the construction of the codelets and those designed to provide an aid to constructing the prototype.

In the case of the code being built to support the codelets, the major motivation is the fact that there are many similarities between the actions of the different codelets. Already discussed above were the functions that implement choosing random items from the Workspace. This is common activity for codelets, mostly differing only in the type of item to be selected. As the

Workspace is implemented using homogenous structures, it is easier to implement a set of functions that take the type of item to be selected as a parameter and return a random item, rather than writing specific pieces of code for each codelet. Many other activities performed by the codelets exhibit this type of duplication. In particular, a host of functions to find the nearest item above, below, to the left, and to the right of a particular position can be reused by the codelets.

In certain cases, new types of capability are being added to the system to increase its flexibility. One of the more interesting of these is the concept of "fuzzy" string matching. In order to make the system more robust in the face of potential OCR errors; attempts to find keywords have been implemented using a partial matching technique. For instance, if a codelet is trying to find the word "Note" on a page and it comes across the string "Nole", it will record this as 75% match, because three of the four letters match. This is obviously not very sophisticated at this level, but it is hoped that effort can be made to study the errors made by the OCR engine to collect statistics on their frequency. With this type of data, a much more sophisticated partial match strategy could be employed. The comparative probability of a particular letter being mis-categorized as another would be used to calculate a better measure of the degree of match.

As much of the development of this system will be done in an iterative manner, a considerable effort has been expended to develop an environment to support the prototype and aid the developer in monitoring the system. A shell has been implemented that enables the developer to view the raster images of the pages loaded into the system, overlaid with structures from the Workspace. This shell also supports the ability to inspect the items in the Workspace and interactively browse through the links between items. The coderack has been implemented so the developer can single step through the processing; pausing after each codelet is run. In addition to these interactive features, there is also a capability to generate log files during each run of the system. These features have increased the design and implementation time at this stage of the development process, but they are in place to support further development as needed.

4.5.3 Future Work

The immediate short-term goal is to complete the development of the prototype system to the point that it can be tested and evaluated. At present, only small-scale tests of the various system components have been carried out. Only when all the major components of the system have been assembled and tested together will it be possible to judge the value of this methodology. From this point forward, development will proceed in an iterative fashion to refine the system to tune the system to process the two chosen types of tables.

Another area of priority is integrating additional image processing technologies into the system, such as symbol recognition adapted from the GCS system. As additional capabilities are developed for other aspects of the ACTI effort, it is hoped that they can also be added. Specific areas discussed above, such as the "fuzzy" text mapping capability and some areas not already discussed such as natural language processing are among some of these capabilities.

In terms of integration with the rest of the ACTI system, it will be necessary to develop an interface that will allow downstream processes to access the results generated by this system. In the particular case of the procedural tables, it should involve a simple translator to read the final structures from the Workspace and convert them either into an intermediate form for final processing or directly into 87269 data elements.

One area of development that has been ignored so far is the need to provide support for quality assurance. An interface will need to be developed that allows the user to correct mistakes made by the system. Whether this will be done while the data is still in the Workspace format or farther downstream is presently undecided. One possibility is that much of the code developed to provide the prototyping environment (data browsers and display systems) could be modified to accommodate some type of editing facility.

In terms of long range goals, it is hoped that the technology developed here will prove useful in recognizing other types of text-oriented pages or possibly even pages containing mixed text and graphics. If the system works as it was designed, it should be possible to develop it into a more general tool for processing different types of documents.

4.6 Finding Implicit and Explicit Links Within Troubleshooting Procedures

Within each procedure of a troubleshooting diagram or table there may be implicit and explicit links. Explicit links name the target of the link [Do table 1, (WP003 O2)], while implicit links do not. To determine implicit links, troubleshooting procedures often have a note such as, "Component locations are shown on figure 1." An example procedure may state "Look at WPN SYS FAIL indicator on Digital Display Indicator ID-2150/ASM-612 in nose wheelwell." WPN SYS FAIL indicator, Digital Display Indicator ID-2150/ASM-612 and nose wheelwell all occur in Figure 4.4-1. Both explicit and implicit links may occur in the same procedure. For example, "Operate APU, right AMAD, in ground maintenance mode (A1-F18AC-LMM-000) and observe caution light indicator panel." APU, right AMAD and caution light indicator panels are found in Figure 4.4-1 while ground maintenance mode operations are found in A1-F18AC-LMM-000.

To determine links within troubleshooting procedures, the conversion system recognizes much of the grammar of troubleshooting procedures, as well as some semantics. To accomplish this, the conversion system must contain some natural language processing capabilities. The grammar of troubleshooting procedures that the conversion system must recognize is at the syntax level. This includes parts of speech such as verbs, nouns, and prepositions. This also includes some level of sentence structure. By determining parts of speech and sentence structure, the conversion system will be able to derive candidate link sources as noun phrases (nouns and any adverb/adjective modifiers such as "nose wheelwell." For the most part, an understanding of semantics will not be necessary. There are cases, however, where some semantic recognition will be necessary. This includes determining transitive and linking verbs as well as determining noun categories. For example, "Decouple left and right AMAD in preparation for ground maintenance mode (A1-F18AC-LMM-000)." Some semantic processing is required to understand that "decouple" is a transitive verb requiring a direct object (left and right AMAD) and that "preparation" is a noun but does not represent a physical object.

"Ground maintenance mode" is a noun phrase that also does not represent an object but is a procedure and, therefore, a link candidate.

Our research has indicated that parsing procedures with dictionary look-up and sentence structure patterns will result in an over classification of link candidates. This means that a noun like "preparation" will be classified as a link candidate. Links themselves may be given more than one target. For example, "Open doors 54L and 54R (A1-F18AC-LMM-010)." If doors 54L and 54R are link candidates, do their targets refer to Figure 4.4-1, A1-F18AC-LMM-010, or both? While the QA process can determine that doors 54L and 54R are either in Figure 4.4-1 or not, the QA process will have difficulty determining whether doors 54L and 54R are in A1-F18AC-LMM-010 or whether the explicit link refers to the procedure of opening the doors.

Our work with respect to determining explicit and implicit links for the next few months will focus on the ability of the conversion system to recognize keywords and sentence structure. We will generate some statistics to determine error rates and classification rates. We will also try to categorize exceptions to determine the best method of handling common errors in classification.

4.7 Natural Language Understanding

Natural language understanding, for the purposes of the ONR contract, refers to three processes. Syntactic Processing is responsible for representing sentence structure or determining language *tokens*. Semantic Interpretation is responsible for assigning *meaning* to words, sentences, and large sentence structures. Contextual Knowledge is responsible for *representing* discourse knowledge and refining semantic interpretation. There are two major purposes for using natural language understanding processing troubleshooting information. First, the troubleshooting system must be able to distinguish between different types of sentence structures found within a manual. These structures include descriptive text, procedural information, and chapter structure. Syntactic Processing alone does not provide enough information for these distinctions. A natural language system makes these distinctions at the Contextual Knowledge level. Various words and sentences may mean different things in different contexts. The natural language system must be able to determine declarative sentences from questions. For this to occur, the system must understand such structures as subject and verb inversions. A natural language system understands these structures at the Semantic Interpretation level. The natural language system also must understand referents of pronouns. A natural language system determines referents from Contextual Knowledge.

4.8 Syntactic Processing

An alphabet is any finite collection of symbols while a string or word is a sequence of alphabetic characters. A language is a set of strings from the input alphabet. Syntactic rules define legal orderings of strings within various sentences. Collectively, these syntactic rules constitute a grammar. Lexemes are the actual strings or words found within a sentence. Syntactic Processing systems group similar lexemes into tokens. Examples of useful tokens are articles (lexemes such as "a," "and," and "the"), prepositions (lexemes such as "to," "for," and "with"), and verbs (lexemes such as "inspect," "verify," and "close").

To describe a language, natural language systems use various conventions such as regular expressions, flow diagrams, and Finite State Automata (FSA). A useful formalism for describing Syntactic Processing systems is context-free grammars and context-sensitive grammars. Computer languages are good examples of context-free grammars. In a context-free grammar, syntax alone determines valid parses of input sentences. This really means that lexemes in the language have a single meaning. In "C," for example, the lexeme "int" is part of the token set identifier type. It does not mean different things in different contexts. In a context-sensitive grammar, natural language systems assign different meaning to lexemes based on context. The word "can" for example can be a verb ("Can the tomatoes"), a noun ("I kicked the can"), and an auxiliary verb ("I can go home now").

Syntactic Processing systems, at a high level, must parse sentences from a language and determine if the sentence is legal. Useful systems, however, will generally associate some action with each legal sentence. These actions may include transforming the sentence into a more useful structure such as a frame (discussed below). To determine if a sentence is legal, the Syntactic Processing system applies rules to groups of tokens. The lexical analysis phase of Syntactic Processing determines these tokens. Lexical analysis performs both morphological analysis and word analysis. Auxiliary structures, lexicons or dictionaries, store the lexemes of the language. The lexicon associates a particular lexeme with a set of valid tokens. Context-sensitive grammars generally augment lexicons with features. Features are such things as number agreement ("plural" and "singular"), person ("first," "second," and "third"), and verb-form ("present," "past," and "infinitive.") Features help context-sensitive grammars determine valid lexeme and token combinations for any particular sentence. Augmented grammars may also contain features that describe valid combinations of tokens.

Under current investigation for the Office of Naval Research (ONR) project are the various parameters necessary to estimate performance of the Syntactic Processing system. These parameters include the type of data structures that are necessary for Syntactic Processing, as well as the size of the lexicon and types of information the lexicon must contain. Finally, we are investigating various forms of grammar to determine the most efficient method of parsing syntax.

4.9 Semantic Interpretation

Semantic interpretation is the process of determining the meaning of various words and phrases. Meaning for the purposes of semantic processing falls into two categories. First, meaning can be *context-dependent.* Context-dependent meaning assigns value to statements based on agreed upon conventions or context. For example, "This fire means someone camped here last night." This sentence implies that the fire is evidence for the conclusion or implies the conclusion that someone was here (wherever here is). A *context-independent* meaning is similar to usages that define words. For example, "Amble means to walk slowly." Context-independent semantic processing determines meaning in terms of other words without reference to the underlying language itself. This type of meaning can be represented by logical form. In general, semantic processing determines word senses such as actions, events, and situations.

For ACTI, the major purpose of semantic processing is to determine the meaning of sentences such as "Open doors 54L and 54R (A1-F18AC-LMM-010)." Syntactic processing and string matching are unable to determine that 54L and 54R are doors. Moreover, the conjunction "and" is often ambiguous and can have different senses. In the above sentence, it is clear that "and" means "door 54L" and "door 54R." In other cases, however, "and" can have a temporal sense. For example, "Open door 54L and check the ignition switch." In this case, it is clear that one must *first* open door 54L *and then* check the ignition switch.

4.10 Image Viewing Utilities

In order to provide basic viewing operations such as zooming and scrolling on a bitmapped image, the image must be scaled. Scaling involves enlarging or reducing the image by some factor. When enlarging an image, each pixel in the source image is replaced by multiple pixels in the destination image. This occurs when the user zooms in to a region of the image. For example, if an image is enlarged by a factor of 2, each pixel in the source image represents a 2x2 block of pixels in the destination image. When reducing an image, each block of pixels in the source image is reduced to a single pixel in the destination image. This is the case when the user zooms out to view a larger portion of the image than will fit directly (100%) inside the image's window. For example, if an image is reduced by a factor of 2, each 2x2 block of pixels in the source image is represented by a single pixel in the destination image.

In past efforts, the image expansion method expanded each source image pixel in the horizontal and vertical dimensions by the enlargement factor. This method is appropriate for recognition applications, where it is desirable to view the actual pixel data, rather than a more visually appealing representation that smoothing algorithms can provide. Image reduction utilized a sampling method where the source image was sampled at reduction factor intervals in the horizontal and vertical dimensions. This method is fast, but yields poor image quality. As the reduction factor increases, image quality rapidly decreases. An example of image reduction using the sampling method is shown in Figure 4.10-1. As this image illustrates, not only is the text unreadable, the structure of the image, in this case a table, is unrecognizable. For this reason, a method that provides higher quality image reduction at an acceptable level of performance is desirable.

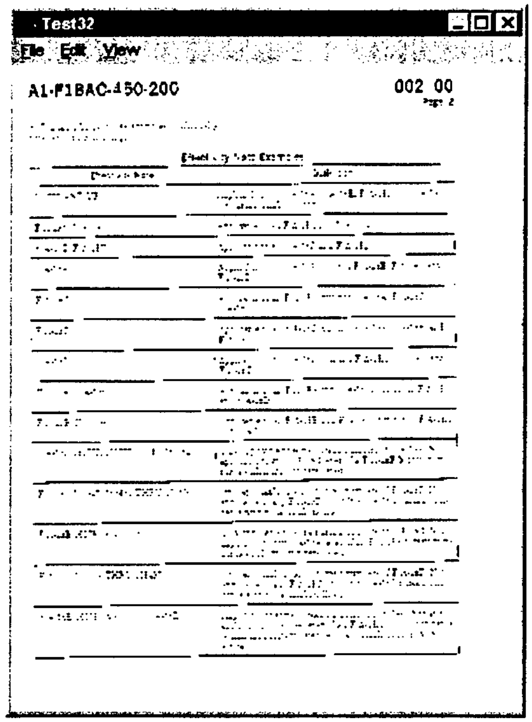

Figure 4.10-1 Image Reduction Using Sampling Method

The approach taken for improving the quality of image reduction is a simple averaging technique. It works by dividing the source image into blocks with width and height equal to the desired reduction factor. It then computes the average pixel value for the block and uses this fraction to compute a gray scale value that is used for the corresponding pixel in the destination image.

The bulk of the algorithm and the most time consuming part of this approach is in counting the pixels that are set in the blocks. The brute force method would be to construct a bit test mask to test each bit individually, shifting between tests to position the mask for the next test. This method would work, but would be very inefficient due to the redundancy of reading the same byte more than once in combination with the shifting required between tests. Another problem is due to the fact that block rows can cross byte boundaries. This means that following each shift of the bit mask is a test of the bit mask. If the condition is true, the source image pointer has to be advanced, and the bit mask reinitialized. These two problems together result in at least two tests and a shift per source image pixel. This makes for an inefficient inner loop that, if possible should be avoided.

As stated above, one significant problem with the brute force approach is that it operates on the image one pixel at a time. To improve on this, masks with multiple bits set can be constructed in order to examine only the image bits of interest. These masks can be stored in Look-Up Tables (LUT), and accessed with the x-coordinate of the source pixel modulus 8 used as the index into the LUTs. Once the masks are determined, they can be used to mask out the unwanted bits of the current source image byte. The resulting value can then be used as an

index into another LUT containing the number of 1s contained in the index. For example, element 0 would equal 0; elements 1, 2, 4, and 8 would equal 1; elements 3, 5, and 6 would equal 2; etc. This value can then be added to the accumulated value in the current destination location.

Another potential optimization was realized while observing that the masks and pixel address increments that were being computed for each row were the same for all rows. This led to the idea of pre-computing them once at the beginning of the routine, and using them for the entire image. These optimizations resulted in a tight inner loop through extensive use of pre-computed arrays and LUTs. The speed improvement was significant. The results as applied to the test image are shown in Figure 4.10-2.

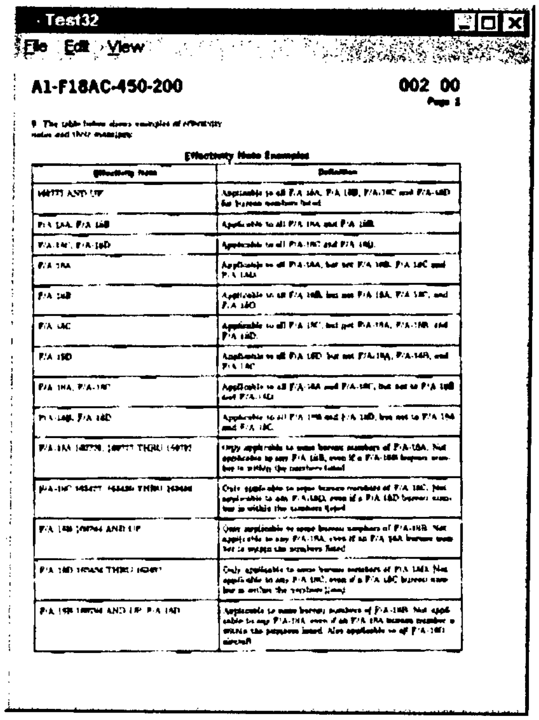

Figure 4.10-2 Using Precomputed Arrays and LUTs

This approach produces acceptable images and is efficient, but does have a limitation. Because an 8-bit gray scale image is used for the destination image, the maximum number of pixels that can be counted is 255. Thus, the minimum reduction factor is 15, or 1/15th of its original size.

4.11 Transparent Editing Utilities

Observations on past recognition projects have indicated that a large percentage of the operator's time is spent verifying that all of the text is correct. Approaches taken have been adequate, but there is still plenty of room for improvement. Because this is a possible bottleneck in any conversion system, it is worthwhile to pursue different approaches in an attempt to minimize the operator's text QA burden.

The method used on the most recent conversion project steps the user through the list of all of a page's text primitives, centers the text in the window, and displays a modeless dialog allowing the user to modify the text if necessary. There are several problems with this approach. First, the dialog box sometimes occludes the text in question, thereby forcing the user to move the dialog box before correcting the text. Another problem is that the text as shown in the dialog box is not similar in appearance to the text on the image. The size and font differences between the two pieces of text make it difficult for the user to efficiently determine what changes, if any, need to be made. A third problem is the positioning of the text. The user is forced to look back and forth between the two pieces of text in order to determine what changes, if any, need to be made. This wastes time and is tiring, as the operator's eyes have to continually adjust to the different text sizes. The bottom line is that this approach works, but is cumbersome and not very efficient.

The basis for the approach taken for improving the text QA process resulted from experience using the existing method. This experience allows the program operator's view to be input directly into the design of the software. It is hoped that this perspective will be reflected in the text QA software.

As described above, there are three problem areas that were targeted for improvement: text occlusion, text font and size discrepancies, and text placement. The approach taken addresses each of these areas, and improves the efficiency of the process significantly. The approach is to allow the text candidates to be edited directly over their bitmapped representations. The text is displayed with a transparent background that allows the bitmapped text to show through. This method has the potential to significantly improve the text QA process. The direct relationship between the text and the bitmapped image allow the user to quickly determine if changes are necessary. Correcting the text is also more straightforward, since the text is entered directly over the bitmapped text.

After implementing this basic approach, it was noticed that the overlaid text was hard to distinguish from the image text. Many text colors were tried, and none showed up very well on top of the black bitmapped text. To improve on this, the image text (and the entire image for that matter) was displayed in a light gray, rather than the normal black. This improved the visibility tremendously. An example of the new text QA method is shown in Figure 4.11-1.

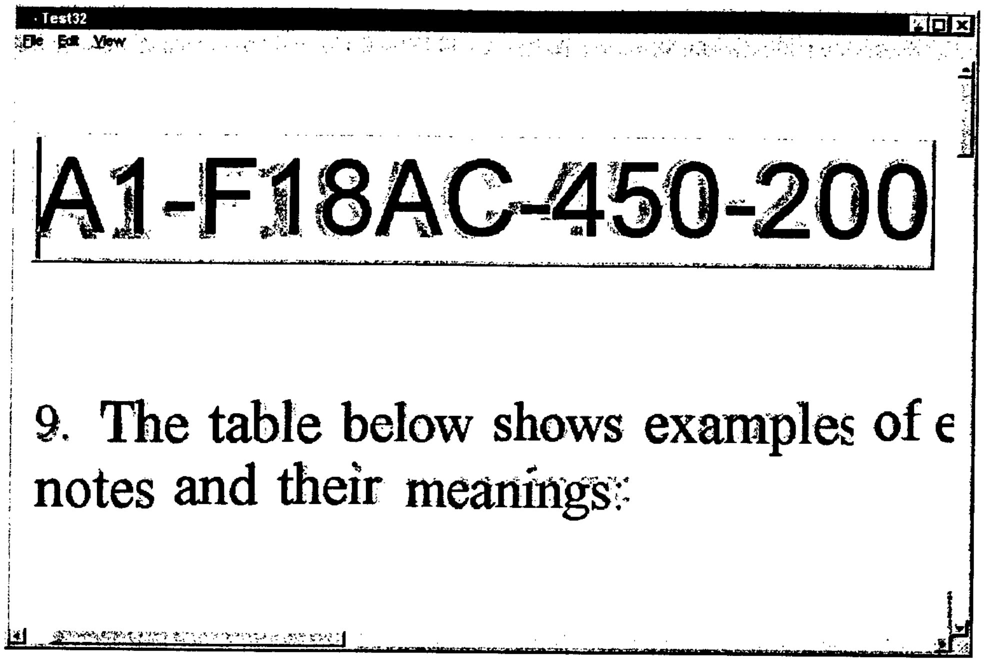

Figure 4.11-1 Example of New Text QA Method

Although the results of the new approach show promise, there is still quite a bit of work to be done in this area. Future efforts will focus on the overall flow of the QA process, as well as improvements to individual text item editing features.

4.12 Database Advances

This report gives a detailed synopsis of developmental issues related to MIL-D-87269 and its implementation.

4.12.1 Element Discovery

A large amount of initial work was spent researching and discussing how the information in a technical manual should be mapped out. To ensure compliance to 87269, it would make sense to map the database design as closely as possible to the standard for technical manuals. We are currently in the process of studying the standard and showing the ways that information contained in a technical manual can be mapped into 87269.

The following are the elements that will be supported.

4.12.2 Primitive Element Declarations

Linking Mechanism

LINK

HyTime	NAME	#FIXED 'ilink'
id	ID	#IMPLIED
anchrole	CDATA	#FIXED 'hotspot target #AGG'
linkends	IDREFS	#REQUIRED
reftype	CDATA	#FIXED 'linkends linkendtypes #SEQ'
extra	NAMES	'A A'
intra	NAMES	'A A'
endterms	IDREFS	#IMPLIED
aggtrav	NAMES	agg

Allows links to several elements of linkendtypes.

HiLink

Allows for HyTime compliant links.

Linkendtypes

Types of designation links:

> link, descinfo, partinfo, text, table, graphic, audio, video, process, para, task, partbase, dialog, entry

nameloc

Defines name locations.

Text

text

id	ID	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED

Text string with embedded data

Contains:

> 0 or more precond elements
> 0 or more link elements
> Parsable character data or TEXT-ALTS or a TEXT element grouped to occur one or more times.

text-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Adds ability to have context sensitive filtering of text.

1 or more text elements.

Table

table

id	ID	#IMPLIED
cdm	IDREF	"node"
ref	IDREF	#CONREF
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED

Defines how a table is constructed.

Contains:

0 or more precond
0 or more links
0 or more rowhddef
0 or 1 colhddef and 1 or more entry elements grouped to occur one or more times.

table-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows context sensitive filtering of tables.

Contains:

1 or more table elements.

rowhddef

id	ID	#IMPLIED
ref	IDREF	#CONREF
row	NUTOKEN	#REQUIRED

Defines a row header for a specific row of a table.

Contains:

1 text entity.

colhddef

id	ID	#IMPLIED
ref	IDREF	#CONREF
colnum	NUTOKEN	#REQUIRED

Defines a column header for a specific column of a table.

Contains one text entity.

Entry

id	ID	#IMPLIED
ref	IDREF	#CONREF
colnum	NUTOKEN	#REQUIRED
row	NUTOKEN	#REQUIRED

Defines an entry for a cell of a table.

Contains:

Either a TEXT or GRAPHIC entity.

Graphics

graphic

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
ref	IDREF	#CONREF
itemid	CDATA	#IMPLIED
minsize	NUTOKENS	#IMPLIED
penshape	CDATA	#IMPLIED
penatt	CDATA	#IMPLIED
transfrm	NUTOKEN	#IMPLIED
window	NUTOKEN	#IMPLIED

Represents a composite graphic made of GRPHPRIM or other GRAPHIC.

Contains:

0 or more precond elements.
0 or more link elements.
1 or more members of graphic entity.

graphic-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for contexts sensitive filtering or graphics.

Contains:

1 or more graphic elements.

grphprim

id	ID	#IMPLIED	
cdm	NAME	"node"	
ref	IDREF	#CONREF	
name	CDATA	#IMPLIED	
type	CDATA	#IMPLIED	
itemid	CDATA	#IMPLIED	
coding	(cgmchar, cgmbin, cgmclear, fax, iges, dxf, gks)		cgmbin
minsize	NUTOKENS	#IMPLIED	
penshape	CDATA	#IMPLIED	
penpatt	CDATA	#IMPLIED	
transfrm	NUTOKEN	#IMPLIED	
x-location	NUTOKEN	#IMPLIED	
y-location	NUTOKEN	#IMPLIED	
window	NUTOKENS	#IMPLIED	

A single graphic component that when combined with other primitives becomes a composite graphic.

Contains:

0 or more PRECOND elements.
0 or more LINK elements.
1 TEXT entity.

grphprim-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of graphic primitives.

Contains:

1 or more grphprim elements.

Audio, Video, and Process
audio
%a.node;
external-ptr IDREF#REQUIRED

Allows audio in the technical information. This element is incomplete in the standard.

Can contain:

0 or more precond.
0 or more link.

audio-alts
%audio-alts

Allows context sensitive filtering of audio sequences.

Can contain:

1 or more audio.

video

id	ID	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
external-ptr	IDREF	#REQUIRED

Used to link to a video sequence from the technical info.

Contains:

0 or more precond elements.
0 or more link elements.

video-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of video sequences.

Contains:

1 or more video elements.

process

id	ID	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
external-ptr	IDREF	#REQUIRED

Used to represent an external software process.

Contains:

0 or more precond elements.
0 or more link elements.
0 or more parameter elements.

process-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of processes.

Contains:

1 or more process.

parameter

mode	in, out, in-out	"in"

Used to pass parameters to or from external software PROCESS.

Contains:

1 expression element.

Dialogs

dialog

id	ID	#IMPLIED
cdm	NAME	'node'
ref	IDREF	#CONREF
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
agent	CDATA	'human'

Allows for retrieval of info from the user.

Contains:

0 or more PRECOND.
0 or more LINK.
0 or more TEXT.
1 or more (DIALOG, FILLIN, MENU, SELECTION).

dialog-alts

id	ID	#IMPLIED
cdm	NAME	'node-alts'
ref	IDREF	#CONREF

Allows for context sensitive filtering of dialogs.

Contains:

1 or more dialogs.

Fillin

id	ID	#IMPLIED
ref	IDREF	#CONREF

Defines a fill in the blank question.

Contains:

- 0 or more links.
- 1 prompt element.
- 1 property element.
- 0 or one text entity.
- 0 or one generic range element.

Generic-range
<Contains no attributes>

Provides a mechanism for defining valid range checking for fillin elements.

Contains:

The set, the sequence or the num-range element.

num-range
<No attributes defined.>

Identifies the maximum and minimum allowable number range.

Contains:

- 1 low-bound element.
- 1 high-bound element.

low-bound
<No attributes defined.>

Identifies the minimum allowable number for a numeric entry of a fill-in-the-blank prompt.

Contains:

- 1 integer or real element.

high-bound
<No attributes defined.>

Identifies the maximum allowable number for a numeric entry of a fill-in-the-blank prompt.

Contains:

1 integer or real element.

Menu

id	ID	#IMPLIED
ref	IDREF	#CONREF
select	(single | multiple)	'single'

Defines a menu for user interaction. Consists of a PROMPT followed by one or more CHOICE elements.

Contains:

0 or more link
1 prompt element
1 or more choice elements

prompt

id	ID	#IMPLIED
ref	IDREF	#CONREF

Defines the prompt to be displayed to the user for the presentation of a FILLIN or MENU.

Contains:

text or graphic entity.

choice

id	ID	#IMPLIED
ref	IDREF	#CONREF
default	(yes | no)	no

Defines a choice in a menu.

Contains the text or graphic entity and one or more assertions or a dialog.

Selection

id	ID	#IMPLIED
ref	IDREF	#CONREF

Provides the ability of creating of creating a special menu that allows selection.

Contains:

1 link followed by 1 or more assertion or dialog elements. This entire grouping can occur 1 or more times.
1 text, table or graphic element.

Context Filtering Element Declarations

precond

id	ID	#IMPLIED
ref	IDREF	#CONREF

Contains an expression that identifies the conditions that must be present to display the technical info.

Contains:

1 expression element.

postcond

id	ID	#IMPLIED
ref	IDREF	#CONREF

Asserts the value of an EXPRESSION to a PROPERTY when a user completes some action.

Contains:

1 assertion element.

binop
unop
value
expression

id	ID	#IMPLIED
ref	IDREF	#IMPLIED

Allows for the creation of mathematical expressions to be used for preconditions and post conditions.

Contains:

> one expression, %binop, expression, or
> one %unop, expression, or
> one property, or
> one value.

assertion

id	ID	#IMPLIED
ref	IDREF	#CONREF

Used to make an assertion from within the content model of an application specific element.

Can contain:

> Property.
> Expression.

eq
ne
lt
gt
le
ge
and
plus
minus
times
divide
intersect
set-diff
member
subset
or
xor

concat
substring
idivide
exponent
mod
union
disjjoint
apppend
subsequence
not
empty
size
head
tail
neg
trunc
float
undef
max
min
add
remove
index
index-value
property

id	ID	#IMPLIED
ref	IDREF	#CONREF
type	CDATA	#REQUIRED
value-type	CDATA	'general'

Contains parsable character data that represents the property (variable) name.

Contains:

Parsable character data.

boolean
string
real
integer
set, sequence
nil

4.12.3 Content Specific DTD - Public Entity Declarations

Techinfo Declaration

techinfo

HyTime	NAME	"HyDoc"
boslevel	NUMBER	#IMPLIED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Represents the top layer of technical info. This is the root element of the 87269 default content layer.

Contains:

1 or more version elements.
1 or more members of the system entity.

System Declaration

system

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Defines the vehicle/system/subsystem/subassembly hierarchy for the weapon system.

Contains:

0 or more precond
0 or more members of system entity
0 or more members of descinfo entity
0 or more members of task entity
0 or more members of partinfo entity
0 or more members of faultinf entity

system-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of elements.

Contains:

1 or more system.

Version Declaration

version

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
revision	NMTOKEN	#REQUIRED
revdate	NUMBERS	#REQUIRED
changeno	NUMBERS	#REQUIRED
chgdate	NUMBER	#REQUIRED
deleted	NMTOKENS	#IMPLIED

Identifies the currency of the data by providing the last revision information and change information necessary for taking delivery of partial databases.

Contains:

0 or 1 members of text entity.

Descriptive Information Declaration

descinfo

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Used to define general purpose, non-procedural , narrative information which are associated with a system.

Contains:

0 or more precond.
0 or more link.
1 para-seq element.
0 or more postcond.

descinfo-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of descriptive information.

Contains:

1 or more descinfo.

Para Declaration

para

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Identifies a piece of text to be displayed.

Contains:

0 or more precond
1 or more members of sum-prims
0 or 1 para-seq
0 or more postcond

para-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of paragraph information.

Contains:

1 or more para.

para-seq

id	ID	#IMPLIED
cdm	NAME	"node-seq"
ref	IDREF	#CONREF

Provides the ability to create sequences of paragraphs.

Contains:

1 or more descinfo, para-alts, if-para, loop-para.

if-para

id	ID	#IMPLIED
cdm	NAME	“node”
ref	IDREF	#CONREF

Allows for conditional selection of paras depending on an expression.

Contains:

> 1 expression.
> 1 para-seq.
> 0 or 1 para-seq.

loop-para

id	ID	#IMPLIED
cdm	NAME	“loop-node”
ref	IDREF	#CONREF

Provides the ability of looping through a sequence of para’s.

Contains:

> 0 or 1 assertion.
> 1 expression.
> 0 or 1 assertion.
> 1 para-seq.

Task Declaration

task

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
esttime	NUTOKEN	#IMPLIED
operability	CDATA	#IMPLIED
servicesdes	CDATA	#IMPLIED

Set of directive steps that make up a specific maintenance procedure.

Contains:

0 or more precond.
0 or more link.
1 member of input entity.
1 step-seq element.
0 or more members of follow-on entity.
0 or more postcond.

task-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of tasks.

Contains:

1 or more task.

Input Declaration

input

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Contains the personnel required, the consumable used, the equipment used, and the required conditions for accomplishing a given task.

Contains:

0 or more precond.
0 or more link.
0 or more members of alert entity.
0 or more members of recond.
1 or more members of person.
0 or more members of refmat.
0 or more members of equip.
0 or more members of expend.
0 or more members of consum.

input-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of input conditions.

Contains:

1 or more input.

Required Condition Declaration

reqcond

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Contains a list of preliminary conditions that must be met prior to beginning a task.

Contains:

0 or more precond.
0 or more link.
0 or more members of text entity.
1 expression element.
1 member of task or step entity.
0 or more assertion.
0 or more postcond.

reqcond-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of required conditions.

Contains:

1 or more reqcond.

Reformat and Expend Declarations

refmat

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
desig	CDATA	#REQUIRED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Used to support inclusion of reference material.

Contains:

0 or more precond.
0 or more link.
0 or one members of text.

refmat-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of reference materials.

Contains:

1 or more refmat.

expend

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
quantity	NUTOKEN	#REQUIRED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Lists expendable materials used during a task.

0 or more precond
0 or more link
0 or 1 member of partbase entity
0 or more consum elements.

expend-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of expendables.

Contains:

1 or more expend

Person Declaration

person

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
quantity	NUTOKEN	#REQUIRED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Used to identify the personnel requirements for a given task.

Contains:

0 or more precond.
0 or more link.
0 or more members of text.

person-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of personnel information

Contains:

1 or more person.

Equipment Declaration

equip

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
quantity	NUTOKEN	#REQUIRED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies the equipment needed to perform a particular task.

Contains:

0 or more precond
0 or more link
0 or more members of equip entity
0 or more members of text entity
1 member of partbase entity

equip-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of equipment elements.

Contains:

1 or more equip elements.

Consumable Declaration

consum

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
govstd	CDATA	#IMPLIED
mfgcode	CDATA	#IMPLIED
milspec	CDATA	#IMPLIED
quantity	NUTOKEN	#REQUIRED
unit of measure	NMTOKEN	#IMPLIED

Identifies all the consumables required for the completion of a task.

Contains:

0 or more precond.
0 or more link.
0 or 1 member of the partinfo entity.
0 or more members of the consum entity.

consum-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of equipment elements.

Contains:

1 or more consum elements.

Alert Declaration

alert

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies an alert message that may accompany a task or step.

Contains:

0 or more precond.
0 or more link.
1 or more members of text entity.
0 or more members of graphic entity.

alert-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context filtering of alerts.

Contains:

1 or more alerts.

Step Declaration

step

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
esttime	NUTOKEN	#IMPLIED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Primary component of a maintenance procedure.

Contains:

0 or more precond.
0 or more link.
0 or more members of sub-prims.
0 or 1 step-seq element.
0 or more postcond.

step-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of steps.

Contains:

1 or more step.

step-seq

id	ID	#IMPLIED
cdm	NAME	"node-seq"
ref	IDREF	#CONREF

Provides the ability to create sequences of steps.

Contains:

1 or more occurrences of (step, step-alts, if-step, loop-step, task, task-alts).

if-step

id	ID	#IMPLIED
cdm	NAME	"if-node"
ref	IDREF	#CONREF

Allows for conditional selection of steps depending on an expression.

Contains:

1 expression element.
1 step-seq element.
0 or 1 step-seq element.

loop-step

id	ID	#IMPLIED
cdm	NAME	"loop-node"
ref	IDREF	#CONREF

Provides the ability of looping through a sequence of steps.

Contains:

0 or 1 assertin.
1 expression.
0 or 1 assertion.
1 step-seq.

Follow on Declaration

follow-on

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

A maintenance condition that must be accomplished sometime following the completion of a task to cleanup or undo actions performed during the task.

Contains:

0 or more precond.
0 or more link.
0 or 1 member of text entity.
1 expression followed by either a member of task or step entity, followed by 0 or more assertion elements.
0 or more postcond.

follow-on-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of follow-on instructions.

Contains:

1 or more follow-on.

Parts Information

partinfo

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
indexnum	NUTOKENS	#IMPLIED
lru	NUTOKENS	#IMPLIED
mtbf	CDATA	#IMPLIED
refdes	CDATA	#IMPLIED
replvl	NUTOKEN	#IMPLIED
unitsper	NUTOKEN	#IMPLIED
usablon	NUTOKEN	#IMPLIED

Describes the maintainers view of the part information.

Contains:

- 0 or more precond.
- 0 or more link.
- 0 or more members of partinfo.
- 1 or more members of partbase.
- 0 or more members of connection.
- 0 or more members of attach-part.
- 0 or more members of text.
- 0 or more members of graphic.
- 0 or more members of location.

partinfo-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of parts information.

Contains:

- 1 or more partinfo.

Partbase Information

partbase

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
cage	NUTOKENS	#REQUIRED
fsc	CDATA	#REQUIRED
partnum	CDATA	#REQUIRED
smr	CDATA	#REQUIRED
nsn	CDATA	#REQUIRED
pmic	CDATA	#IMPLIED
cac	NUTOKEN	#IMPLIED
qpei	NUTOKEN	#IMPLIED
hci	(Y1 | N1)	"N1"
lox	(Y2 | N2)	"N2"
esds	(Y3 | N3)	"N3"
qec	(Y4 | N4)	"N4"
magnetic	(Y5 | N5)	"N5"

Describes the supply systems view of the part information.

Contains:

0 or more precond.
0 or more link.
0 or more members of partbase.
0 or one text.
0 or more members of location.

partbase-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of Base Supply parts

Contains:

1 or more partbase.

Connecting and Attaching Parts Declaration

connection

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies a connection between 2 part info elements.

Contains:

- 0 or more precond.
- 0 or more link.
- 1 or more partinfo entities.

connection-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of connection elements.

Contains:

- 1 or more connection elements.

attach-part

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies all of the attaching parts required for a given part info element.

Contains:

0 or more precond.
0 or more link.
1 or more members of the partinfo entity.

attach-part-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of ATTACH-PART.

Contains:

1 or more attach-part elements.

Location Declaration

location

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
location-x	NUTOKENS	#IMPLIED
location-y	NUTOKENS	#IMPLIED
location-z	NUTOKENS	#IMPLIED

Provided information for physical assessment.

Contains:

0 or more precond.
0 or more link.

location-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of locations.

Contains:

1 or more location.

Fault Information Declaration

faultinf

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Used to define all the tests and faults associated with the system that refers to it.

Contains:

0 or more precond.
0 or more link.
1 or more members of test entity.
0 or more members of fault entity.

faultinf-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of fault information.

Contains:

1 or more faultinf.

Test Declaration

test

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
agent	CDATA	"human"
range	CDATA	#IMPLIED

Indicates a diagnostic test that will lead to outcomes and guide the technician toward a rectification during troubleshooting.

Contains:

0 or more precond.
0 or more link.
1 member of task entity.
1 or more members of outcome entity.

test-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of tests.

Contains:

1 or more test.

Outcome Declaration

outcome

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF

Represents a possible outcome from a test.

Contains:

0 or more precond.
0 or more link.
1 expression.
a member of 1 of the following (fltstate, test or fault, 0 or 1 member of fltstate) Note the nested or condition when resolving this content model.

outcome-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of outcomes for a test.

Contains:

1 or more outcome.

Faultstate Declaration

fltstate

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
weight	NUTOKENS	#IMPLIED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies a set of implicated or explicated faults. Implicated fault is fault suspected of being bad. Explicated fault is fault known to be good.

Contains:

0 or more precond.
0 or more link.
1 or more members of fault entity.

fltstate-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of fault states.

Contains:

1 or more fltstate.

Fault Declaration

fault

version	IDREF	#REQUIRED
status	"u" or "a"	"a"
mtbf	CDATA	#IMPLIED
id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	"node"
ref	IDREF	#CONREF

Identifies a potential failure that may occur on a weapon system.

Contains:

0 or more precond.
0 or more link.
1 or more members of either RECT or FLTSTAT entities.
1 or more members of system entities.

fault-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of fault information.

Contains:

1 or more fault.

Rectification Declaration

rect

id	ID	#IMPLIED
name	CDATA	#IMPLIED
type	CDATA	#IMPLIED
itemid	CDATA	#IMPLIED
cdm	NAME	#FIXED
ref	IDREF	#CONREF
version	IDREF	#REQUIRED
status	"u" or "a"	"a"
action	"swap" or "maint"	"maint"
agent	CDATA	"human"

Identifies the prescribed task that will repair the fault causing the discrepancy and all other faults that could be fixed be the rectification.

Contains:

0 or more precond.
0 or more link.
1 or more members of task.
1 or more members of fault.
1 member of system.
0 or more members of test.

rect-alts

id	ID	#IMPLIED
cdm	NAME	"node-alts"
ref	IDREF	#CONREF

Allows for context sensitive filtering of rectifications.

Contains:

1 or more rect.

4.13 Exploration Into Element Implementation

Time in this area was spent taking the elements defined from MIL-D-87269 from previous analysis and implementing them as a database schema. The target database is Oracle Release 7.3.2.1.0 running on an HP 9000. We are currently using ERWin to define the schema.

There are many issues concerning the database that need to be resolved. Since the tables defined in MIL-D-87269 are for the final representation of the IETM, it does not sufficiently cover the tables needed to represent intermediate information created by the conversion process. Information such as raw text and graphics, grammars and rules needed for natural language processing, as well as partially converted information generated by the conversion process. Currently these issues are unresolved and will be discussed in further detail as solutions are devised.

4.14 Detailed Element Examination

The following are elements that have been identified in the manual A1-F18AE-580-200. This is the first part of an effort to formulate a guide meant to be used to help properly and uniformly classify elements as they appear in a manual. Each element described here has a brief description, a list of the properties that help uniquely identify this element in the manual, a list of which elements the current element can be derived from, and an example of the element.

The following elements are not directly obtained by the conversion process: audio, audio-alts, video, video-alts.

4.14.1 System

Defines the hierarchy of the weapon system. It must be created for any component that has associated technical information.

Properties of element:

Placement on a page.
Format of content.

Domain of element:

Can exist only in techinfo, system, system-alt, rect, or fault elements.

Example of element:

A1-F18AE-580-200 — 1 March 1996

001 00 — Page 1/(2 blank)

ALPHABETICAL INDEX

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

FLIGHT INCIDENT RECORDER AND MONITORING SYSTEM

Title	WP Number
Circuit Breakers	004 00
Component Locator	
Deployable Flight Incident Recorder Set (DFIRS)	012 00
Flight Incident Recorder and Monitoring System	003 00
Introduction	002 00
Diagrams	002 00
Effectivities	002 00
Illustrated Parts Breakdown	002 00
Manual Issue Date	002 00
Navy (AN) Standard/Common Name Nomenclature	002 00
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Record of Applicable Technical Directives	002 00
Requisitioning and Distribution of NAVAIR Technical Publications	002 00
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List of Technical Publication Deficiency Reports Incorporated	TPDR-1
Memory Inspect Data	006 00
Recorder - Monitoring Set AN/ASQ-194 Test	005 00
Troubleshooting	
Deployable Flight Incident Recorder Set (DFIRS)	013 00
Memory Unit	008 00
Nose Wheelwell Digital Display Indicator	009 00
Signal Data Computer	007 00
Strain Gages - Part I	010 00
Strain Gages - Part II	011 00
Work Package Index	001 01

Figure 4.14.1-1 Example of System

4.14.2 Version

Provides revision information and change information.

Properties of element:

Contains the date of publication for the technical manual.

Domain of element:

Can exist only in techinfo, but can be referenced by system, descinfo, para, task, input, reqcond, refmat, expend, person, equip, consum, alert, step, follow-on, partinfo, partbase, connection, attach-part, location, faultinf, test, outcome, fltstate, fault, or rect elements.

Example of element:

A1-F18AE-580-200
1 March 1996

TECHNICAL MANUAL

ORGANIZATIONAL MAINTENANCE
TESTING AND TROUBLESHOOTING

FLIGHT INCIDENT RECORDER AND MONITORING SYSTEM

NAVY MODEL

F/A-18C AND F/A-18D

This manual supersedes A1-F18AE-580-200, dated 1 April 1989, changed 1 September 1994.

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Figure 4.14.2-1 Example of Version

4.14.3 Precond

Contains an expression that identifies the conditions that must be present to display the technical information.

Properties of element:

Effectivity symbols on the page.
Heading of effectivity.
Sentences in legends containing terms that denote inclusion/exclusion from a set (applies for ..., ... and up, ... thru ..., ...)

Domain of element:

Can exist only in text, table, graphic, grphprim, audio, video, process, dialog, system, descinfo, para, task, input, reqcond, refmat, expend, person, equip, consum, alert, step, follow-on, partinfo, partbase, connection, attach-part, location, faultinf, test, outcome, fltstate, fault, or rect elements.

Example of element:

Table 2. Maintenance Action For System Maintenance Codes (Continued)

Maintenance Code	Troubleshooting for Maintenance Codes
[3] 320	DFIRS memory test fail. Replace DFIRS signal data recorder (A1-F18AE-580-300, WP013 00).
[3] 321	DFIRS signal data recorder fail. Replace DFIRS signal data recorder (A1-F18AE-580-300, WP013 00).
[3] 322	DFIRS data transfer interface unit fail. Replace DFIRS data transfer interface unit (A1-F18AE-580-300, WP014 00).
600	Do table 1, WP010 00.
601	Do table 2, WP010 00.
602	Do table 3, WP010 00.
603	Do table 4, WP010 00.
604	Do table 1, WP011 00.
605	Do table 2, WP011 00.
606	Do table 3, WP011 00.
[2] 809	Replace memory unit (A1-F18AE-580-300, WP005 00).
812	Replace memory unit (A1-F18AE-580-300, WP005 00).
926	Do table 4, WP011 00.
995	If not set during fluids test, do table 2, WP009 00.

[1] If component was replaced and malfunction still exists, start troubleshooting at step 2.
[2] With DIGITAL DATA COMPUTER CONFIG/IDENT 91C AND UP.
[3] 164725 AND UP; ALSO 164627 THRU 164724 AFTER F/A-18 AFC 126 WITH DIGITAL DATA COMPUTER CONFIG/IDENT 91C AND UP.

Figure 4.14.3-1 Example of Precond

4.14.4 Alert

Used to identify an alert message that may accompany a task or a step. There are three general types of alerts:

1. Warning - Notifies technician that task or step may be harmful to himself or others if not properly performed.
2. Caution - Emphasizes a procedure that, if not strictly maintained, may result in damage to equipment.
3. Note - Used to emphasize an important procedure or condition.

Properties of element:

Keyword in heading (Note, Caution, Warning)
Symbol ()

Domain of element:

Can exist only in alert-alt, input, or step elements.

Example of element:

A1-F18AE-580-200 **010 00**

Page 7

Table 3. Left Horizontal Stabilator Strain Gage (85M-U013 or 85M-U113) Fail (Maintenance Code 602)

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
77/BN (77/AN)	Multimeter

Materials Required

None

NOTE

Fatigue Strain Data Schematic (A1-F18AE-580-500, WP008 00) may be used as an aid when doing this procedure.

For component locator, refer to WP003 00.

Malfunction is caused by one of the items listed below:

Aircraft Wiring
Left Horizontal Stabilator Strain Gage
Signal Data Computer

Procedure	No	Yes

CAUTION

To prevent damage to low level devices (switches/relay contacts), do not test for continuity with multimeter on the RX1 scale. Pin to pin tests that do not go through switches/relay contacts may use the RX1 scale.

Figure 4.14.4-1 Example of Alert

4.14.5 Descinfo

Used to define general purpose, non-procedural, narrative information that is associated with a system component. Can be used to describe any hierarchical node.

Properties of element:

Anything that does not map to any other element.

Domain of element:

Can exist only in link, descinfo-alts, or system elements.

Example of element:

A1-F18AE-580-200 **002 00**

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ORGANIZATIONAL MAINTENANCE

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FLIGHT INCIDENT RECORDER AND MONITORING SYSTEM

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NOTE

Aircraft with model designator F/A-18B are the same type and model as TF/A-18A.

a. Type, model, and series

NOTE

F/A-18D aircraft after bureau number 164967 is referred to as bureau number F/A-18D D-140.

b. Bureau number (tail number)

c. Combination of type, model, series, and bureau numbers

d. Part number or serial number

e. Technical directive number

f. Configuration/identification number

Figure 4.14.5-1 Example of Descinfo

4.14.6 Refmat

Used to support inclusion of reference material.

Properties of element:

Keyword in heading. (Reference Material, ...)
Exist only at the beginning of a task.

Domain of element:

Can exist only in refmat-alts, or input elements.

Example of element:

A1-F18AE-580-200 **005 00**
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TESTING AND TROUBLESHOOTING

RECORDER - MONITORING SET AN/ASQ-194 TEST

FLIGHT INCIDENT RECORDER AND MONITORING SYSTEM

Reference Material

Line Maintenance Procedures...A1-F18AC-LMM-000

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No.	Date Incorp.	Remarks
F/A-18 AFC 126	1 Oct 94	Addition of (DFIRS) Deployable Flight Incident Recorder Set (ECP 321R1C1)	1 Dec 92	-

Table 1. Recorder-Monitoring Set AN/ASQ-194 Test

Procedure	Normal Indication	Remedy for Abnormal Indication

System Required Components

Nose Wheelwell Digital Display Indicator
Memory Unit
Signal Data Computer
I DFIRS Signal Data Recorder
I DFIRS Data Transfer Interface Unit

Related Systems Required

Avionics Cooling System
Electrical Systems
Mission Computer System
Multipurpose Display Group

Support Equipment Required

Figure 4.14.6-1 Example of Refmat

4.14.7 Equip

Identifies the equipment needed to perform a particular task. Usually refers to a piece of test equipment, support equipment or tool.

Properties of element:

Keyword in heading. (Support Equipment Required, ...)
Exists only at the beginning of a task.

Domain of element:

Can exist only in equip, equip-alts, or input elements.

Example of element:

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Line Maintenance Procedures A1-F18AC-LMM-000

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Signal Data Computer
I DFIRS Signal Data Recorder
I DFIRS Data Transfer Interface Unit

Related Systems Required

Avionics Cooling System
Electrical Systems
Mission Computer System
Multipurpose Display Group

Support Equipment Required

Figure 4.14.7-1 Example of Refmat

4.14.8 Reqcond

Contains a list of preliminary conditions that must be met prior to beginning a task. If any condition is not met, it contains the task or step that will satisfy the condition. It also may contain postconditions that will record the state changes made.

Properties of element:

Exist only at the beginning of a task.

Domain of element:

Can only exist in reqcond-alts or input elements.

Example of element:

No example available.

4.14.9 Task

A set of directive steps which make up a specific maintenance procedure.

Properties of element:

Often appear in tables having headings such as (Procedure, No, Yes), (Procedure, Normal Indication, Remedy for Abnormal Indication), ...

Domain of element:

Can only exist in link, follow-on, rect, reqcond, step-seq, system, task-alts, or test elements.

Example of element:

A1-F18AE-580-200 **005 00**

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Table 1. Recorder-Monitoring Set AN/ASQ-194 Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
	None	
	Materials Required	
	None	
	NOTE If a malfunction occurs during this test, make sure circuit breakers listed in WP004 00 are closed. For test displays, refer to figure 1. For component locator, refer to WP003 00 and WP012 00.	
1. PRELIMINARY.		
a. If external power is not applied or generators are not operating, in nose wheelwell, momentarily set MMP ENABLE/BRCU switch to RESET.		
b. In nose wheelwell, press nose wheelwell digital display indicator AMI BIT/RESET switch and hold for approximately 3 seconds.	000 flashes and in approximately 3 seconds test code 888 appears on MAINTENANCE CODE display for approximately 5 seconds and then goes blank.	1. If no displays, do table 1, WP009 00. 2. If digit missing, do table 4, WP009 00. 3. If segment missing, do table 5, WP009 00.
c. Apply electrical power (A1-F18AC-LMM-000).		
d. ON 164627 THRU 164724 BEFORE F/A-18 AFC-126, on GND PWR control panel assembly, set and hold 1 switch to A ON, 2 switch to B ON. ON 164725 AND UP; ALSO 164627 THRU 164724 AFTER F/A-18 AFC 126, on GND PWR control panel assembly, set and hold 3 switch to A ON or B ON, for three seconds.	Switches remain on (latched).	1. If switches unlatch in 10 to 30 seconds, apply external cooling air to aircraft (A1-F18AC-LMM-000). 2. If switches do not remain on, troubleshoot (A1-F18AC-FIM-000, WP012 00).

Figure 4.14.9-1 Example of Task

4.14.10 Step

The primary component of a maintenance procedure describing the actions to be performed in order to complete a task.

Properties of element:

Properties of parent entities.
Labeling and indention of steps.

Domain of element:

Can only exist in step-seq, reqcond, loop-step, if-step, or follow-on elements.

Example of element:

A1-F18AE-580-200 **005 00**
Page 2

Table 1. Recorder-Monitoring Set AN/ASQ-194 Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
	None	
	Materials Required	
	None	
	NOTE	
	If a malfunction occurs during this test, make sure circuit breakers listed in WP004 00 are closed.	
	For test displays, refer to figure 1. For component locator, refer to WP003 00 and WP012 00.	
1. PRELIMINARY.		
a. If external power is not applied or generators are not operating, in nose wheelwell momentarily set MMP ENABLE/BRCU switch to RESET.		
b. [illegible] wheelwell, press [illegible] display indicator BIT/RESET switch and [illegible] for approximately 3 seconds.	[illegible] flashes [illegible] MAINTENANCE [illegible] approximately [illegible]	[illegible] WP002 00 [illegible]
c. Apply electrical power (A1-F18AC-LMM-000).		
d. ON 164627 THRU 164724 BEFORE F/A-18 AFC 126, on GND PWR control panel assembly, set and hold 1 switch to A ON, 2 switch to B ON. ON 164725 AND UP, ALSO 164627 THRU 164724 AFTER F/A-18 AFC 126, on GND PWR control panel assembly, set and hold 3 switch to A ON or B ON, for three seconds.	Switches remain in [illegible]	[illegible] (A1-F18AC-LMM-000) [illegible]

Figure 4.14.10-1 Example of Step

4.14.11 Graphic

Used to represent a composite graphic made of graphic primitives or other graphics.

Properties of element:
- Any illustration.
- Keywords in caption. (Graphic, Illustration, ...)

Domain of element:
- Can only exist in graphic, graphic-alts, choice, entry, prompt, selection, alert, para, partinfo, or step elements.

Example of element:

A1-F18AE-580-200 **012 00**
Page 2

52A-D026	NO. 4 CIRCUIT BREAKER PANEL ASSEMBLY		
ZONE	REF DES	NOMENCLATURE	BUS
02	85CBD046	DFIRS POWER	R 28VDC

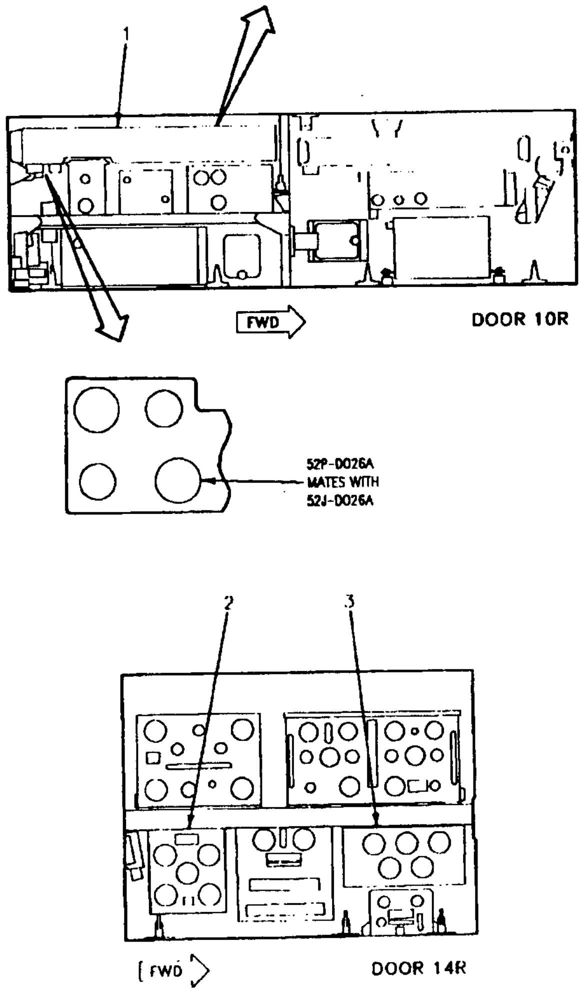

Figure 1. Component Locator - Deployable Flight Incident Recorder Set (DFIRS) (Sheet 1)

Figure 4.14.11-1 Example of Graphic

4.14.12 Text

Used to define how text is constructed. There may be embedded text elements that allow referencing of other elements.

Properties of element:

Any textual information that occurs in a manual that is not directly used by other elements.

Domain of element:

Can only exist in choice, colhddef, dialog, entry, fillin, grphprim, link, prompt, rowhddef, selection, text, text-alts, alert, equip, follow-on, para, partbase, partinfo, person, refmat, reqcond, step, or version elements.

Example of element:

A1-F18AE-580-200 **002 00**

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Aircraft with model designator F/A-18B are the same type and model as TF/A-18A.

a. Type, model, and series

NOTE

F/A-18D aircraft after bureau number 164967 is referred to as bureau number F/A-18D D-140.

b. Bureau number (tail number)

c. Combination of type, model, series, and bureau numbers

d. Part number or serial number

e. Technical directive number

f. Configuration/identification number

Figure 4.14.12-1 Example of Text

4.14.13 Link

Provides for the ability to create relational links.

Properties of element:

Occurs anywhere that extended information is available about an entity.

Domain of element:

Can only exist in test, task, system, step, reqcond, refmat, rect, person, partinfo, partbase, outcome, location, input, follow-on, fltstate, faultinf, fault, expend, equip, descinfo, consum, connection, attach-part, alert, video, text, table, selection, process, menu, link, grphprim, graphic, fillin, dialog, or audio elements.

Example of element:

A1-F18AE-580-200 **005 00**

Page 2

Table 1. Recorder-Monitoring Set AN/ASQ-194 Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
	None	
	Materials Required	
	None	
	NOTE	
If a malfunction occurs during this test, make sure circuit breakers listed in WP004 00 are closed.		
For test displays, refer to figure 1. For component locator, refer to WP003 00 and WP012 00.		
1. PRELIMINARY.		
a. If external power is not applied or generators are not operating, in nose wheelwell, momentarily set MMP ENABLE/BRCU switch to RESET.		
b. In nose wheelwell, press nose wheelwell digital display indicator AMI BIT/RESET switch and hold for approximately 3 seconds.	000 flashes and in approximately 3 seconds test code 888 appears on MAINTENANCE CODE display for approximately 5 seconds and then goes blank.	1. If no displays, do table 1, WP009 00. 2. If digit missing, do table 4, WP009 00. 3. If segment missing, do table 5, WP009 00.
c. Apply electrical power (A1-F18AC-LMM-000).		
d. ON 164627 THRU 164724 BEFORE F/A-18 AFC-126, on GND PWR control panel assembly, set and hold 1 switch to A ON, 2 switch to B ON. ON 164725 AND UP; ALSO 164627 THRU 164724 AFTER F/A-18 AFC 126, on GND PWR control panel assembly, set and hold 3 switch to A ON or B ON, for three seconds.	Switches remain on (latched).	1. If switches unlatch in 10 to 30 seconds, apply external cooling air to aircraft (A1-F18AC-LMM-000). 2. If switches do not remain on, troubleshoot (A1-F18AC-FIM-000, WP012 00).

Figure 4.14.13-1 Example of Link

4.14.14 Table

Defines how a table is constructed.

Properties of element:

Lines on page used to denote column boundaries.
Title of the table. (Table, ...)
The information found in the table doesn't map to another element such as task.

Domain of element:

Can only exist in selection, table-alts, link, para, or step elements.

Example of element:

A1-F18AE-580-200 **001 00**

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ALPHABETICAL INDEX

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Figure 4.14.14-1 Example of Table

4.14.15 Dialog

Used to retrieve information from the user.

Properties of element:

Asks a question that requires a response.
A statement is made and the user must make a choice from a table.

Domain of element:

Can only exist in dialog, dialog-alts, selection, or link elements.

Example of element:

Table 4. Code 926 (Continued)

Procedure	No	Yes
Are all resistance indications in tolerance?	e	i
e. Are all resistance indications for backup strain gage out of tolerance?	as	am
f. Do resistance tests below on primary strain gage: 85P-F042B pin 31 to pin 20 (980 to 1020 ohms) 85P-F042B pin 19 to pin 20 (495 to 545 ohms) 85P-F042B pin 41 to pin 20 (495 to 545 ohms) 85P-F042B pin 41 to pin 31 (495 to 545 ohms) 85P-F042B pin 19 to pin 31 (495 to 545 ohms)		
Are all resistance indications in tolerance?	g	i
g. Are all resistance indications for primary strain gage out of tolerance?	as	h
h. On nose wheelwell DDI, place S2 to BACKUP. Document BACKUP switch position selected for S2 on Miscellaneous History Card OPNAV 4790/25A, part of aircraft log book and do step av		
i. On nose wheelwell DDI, is S3 in PRIMARY position?	j	l
j. Do resistance tests below on backup strain gage: 85P-F042B pin 99 to pin 87 (980 to 1020 ohms) 85P-F042B pin 19 to pin 87 (495 to 545 ohms) 85P-F042B pin 41 to pin 87 (495 to 545 ohms) 85P-F042B pin 41 to pin 99 (495 to 545 ohms) 85P-F042B pin 19 to pin 99 (495 to 545 ohms)		
Are all resistance indications in tolerance?	k	o
k. Are all resistance indications for backup strain gage out of tolerance?	as	am
l. Do resistance tests below on primary strain gage: 85P-F042B pin 21 to pin 12 (980 to 1020 ohms) 85P-F042B pin 19 to pin 12 (495 to 545 ohms) 85P-F042B pin 41 to pin 12 (495 to 545 ohms) 85P-F042B pin 41 to pin 21 (495 to 545 ohms) 85P-F042B pin 19 to pin 21 (495 to 545 ohms)		
Are all resistance indications in tolerance?	m	o
m. Are all resistance indications for primary strain gage out of tolerance?	as	n
n. On nose wheelwell DDI, place S3 to BACKUP. Document BACKUP switch position selected for S3 on Miscellaneous History Card OPNAV 4790/25A, part of aircraft log book and do step av		

Figure 4.14.15-1 Example of Dialog

4.15 Oracle Evaluation

Work in May consisted of performing a product evaluation as well as learning new software. The use of the ORACLE database on our HP server was found insufficient. The problems are not because of the performance of the machine but the performance of the connection to the machine. The HP server available to us is located at the main office here in Fairmont. The network connection is a fractional T1 capable of handle roughly 1.5Mbps. By using a local Windows NT workstation we can take advantage of our network which supports up to 100 Mbps. We have obtained a trial version of ORACLE Workgroup Server for Windows NT. We have had problems installing the database server on Windows NT v3.51 but it does install correctly on Windows NT 4.0.

After much reading we have created a new database and have it online for ACTI development. To develop database interface code for the ORACLE database we have purchased ORACLE Programmer 2000. This contains the Pro*C/C++ programming interface for Windows NT. Pro*C/C++ allows one to embed SQL database calls into a C/C++ program. This is necessary for the development of the client/server application model.

A few test programs have been developed to test the usability and performance of the ORACLE database. Due to the need to precompile all source files with embedded SQL, it makes the final C/C++ files hard to follow and debug. However, since database SQL layout is essentially the same from function to function, bugs within the SQL queries should all but disappear and the debugging problem should not be an issue.

4.16 Comparison to Lockheed-Martin Implementation

Addressing the issue of adherence to MIL-D-87269 ManTech and Lockheed-Martin have the same goal—follow the standard as closely as the specification of the standard allows. We say "as closely as the specification of the standard allows" because of vague areas of the standard as well as possible errors that occur in the standard. An example of problems is the elements used to represent fault information.

We agree with Lockheed-Martin that it is not clear how fault isolation information is intended to be mapped into 87269. Their tentative solution to the problem is a drastic change from the content in 87269. While the change may be drastic, the specification in its current form has several errors and hence can not be implemented as specified. We assume that only a small amount of effort was spent by Lockheed-Martin on Fault Isolation Information. We make this assumption from the following observations:

- Small dataset containing Fault Isolation Information
- No data was analyzed on Flow Diagrams
- Tight restrictions imposed on the contents of the data in tabular fault isolation data
- The inability to handle all fault isolation information in the final system

4.17 Summary of Results

This report closes out the database developments related to Phase 1 of ACTI. Issues covered in this phase included:

- Detailed Analysis of 87269.
- Formulating an approach for implementation.
- Making a connection between 87269 elements and the contents of Legacy Paper Technical Manuals.
- Evaluating ORACLE Workgroup Server and Pro*C/C++.
- Experimenting with database schema implementations in ERWin.

In future work the developments related to the database should be more implementation oriented instead of solely research oriented.

APPENDIX A: PROCEDURE/NORMAL INDICATION/REMEDY

A1.0 PROCEDURE/NORMAL INDICATION/REMEDY

The following is an example of a procedure/normal indication/remedy table as found in troubleshooting information. This type of table accounted for 1,216 out of 13, 518 pages surveyed.

A1-F18AE-760-200 **018 00**

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Table 1. ALQ-165 (ASPJ) Built-In Test

System Required Components

All system components installed.

Related Systems Required

Avionics Cooling System
Electrical System
Flight Incident Recorder and Monitoring System
Mission Computer System
Multipurpose Display Group
Warning/Caution/Advisory System

Support Equipment Required

None

Materials Required

None

NOTE

If a malfunction occurs during this test, make sure circuit breakers listed in WP015 00 are closed.

For component locator, refer to WP015 00.

For Built-In Test Displays, refer to figure 1.

Procedure	Normal Indication	Remedy for Abnormal Indication
1. PRELIMINARY.		
a. Do nose wheelwell digital display indicator built-in test/ reset procedure (A1-F18AC-LMM-000).		
b. Apply electrical power (A1-F18AC-LMM-000).		
c. On GND PWR control panel assembly, set 1 and 2 switches to B ON and 3 switch to A ON and hold for 3 seconds.	Switches remain on (latched).	1. If switches unlatch in 10 to 30 seconds, do external ground cooling air application procedure (A1-F18AC-LMM-000). 2. If switches do not remain on, troubleshoot

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data

Table 1. ALQ-165 (ASPJ) Built-In Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
d. If MBIT is being started, do external ground cooling air application procedure (A1-F18AC-LMM-000).		
e. On left and right digital display indicators, (LDDI and RDDI), set power switch to DAY or NIGHT and allow 2 minute warmup. Adjust BRT and CONT controls for best display.	1. LDDI and RDDI have display and center pusbutton switch on bottom row is labeled MENU .	1. No display on LDDI: ON F/A-18C 163427 THRU 163782, do table 1 (A1-F18AC-745-200, WP006 00). ON F/A-18D 163434 THRU 163778, do table 1 A1-F18AC-745-200, WP007 00). ON F/A-18C 163985 AND UP, do table 1 (A1-F18AG-745-200, WP006 00). ON F/A-18D 163986 AND UP, do table 1 (A1-F18AG-745-200, WP007 00). 2. No display on RDDI: ON F/A-18C 163427 THRU 163782, do table 2 (A1-F18AC-745-200, WP006 00). ON F/A-18D 163434 THRU 163778, do table 2 (A1-F18AC-745-200, WP007 00). ON F/A-18C 163985 AND UP, do table 2 (A1-F18AG-745-200, WP006 00). ON F/A-18D 163986 AND UP, do table 2 (A1-F18AG-745-200, WP007 00). 3. If STANDBY is displayed: ON F/A-18C 163427 THRU 163782, do table 2 (A1-F18AC-745-200, WP004 00).

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data (continued)

Table 1. ALQ-165 (ASPJ) Built-In Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
		ON F/A-18D 163434 THRU 163778, do table 2 (A1-F18AC-745-200, WP005 00). ON F/A-18C 163985 AND UP, do table 2 (A1-F18AG-745-200, WP004 00). ON F/A-18D 163986 AND UP, do table 2 (A1-F18AG-745-200, WP005 00). 4. If BRT or CONT controls do not affect display, replace RDDI or LDDI: ON 163427 THRU 163782 (A1-F18AC-745-300, WP004 00). ON 163985 AND UP (A1-F18AG-745-300, WP004 00).
	2. LDDI has cautions and advisory display.	Replace RDDI: ON 163427 THRU 163782 (A1-F18AC-745-300, WP004 00). ON 163985 AND UP (A1-F18AG-745-300, WP004 00).
f. ON F/A-18C AND ON F/A-18D 163434 THRU 163778, on ECM control panel assembly, set ECM mode switch to STBY.	In cockpit on LH advisory and threat warning indicator panel, STBY light comes on. Light goes off in approximately 3 minutes.	1. STBY light did not come on, do table 1, WP019 00. 2. STBY light did not go off in 5 minutes, do step 2.
g. ON F/A-18D 163986 AND UP, on ECM control panel assembly, set ECM mode switch to STBY.	On LH advisory and threat warning indicator panel in cockpit, and on rear advisory and threat warning indicator panel in rear cockpit, STBY light comes on. Light goes off in approximately 3 minutes.	1. STBY light on one or both advisory and threat warning indicator panels did not come on, do table 2, WP019 00. 2. STBY light did not go off in 5 minutes, do step 2.
2. PROCEDURE.		

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data (continued)

Table 1. ALQ-165 (ASPJ) Built-In Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
WARNING During this procedure (step 2) an rf hazard exists which may cause personal injury. Make sure all personnel are at least 12 feet clear of ASPJ transmit antennas.		
CAUTION To prevent damage to ASPJ equipment, do not perform more than one IBIT every 20 minutes without engines running above 75%. To prevent damage to ASPJ equipment, do not initiate MBIT without external cooling air applied or without engines running above 75%.		
NOTE Observe local radio and radar operating regulations while doing the test to prevent violating security.		
a. On RDDI press and release MENU pusbutton switch until BIT pusbutton switch option is displayed.	RDDI has menu display and center pusbutton switch on top is labeled BIT (fig 1).	Replace RDDI: ON 163427 THRU 163782 (A1-F18AC-745-300, WP004 00). ON 163985 AND UP (A1-F18AG-745-300, WP004 00).
b. Press and release BIT push-button switch.	RDDI has BIT control display.	Replace RDDI: ON 163427 THRU 163782 (A1-F18AC-745-300, WP004 00). ON 163985 AND UP (A1-F18AG-745-300, WP004 00).
c. Press and release EW BIT pusbutton switch.	RDDI has EW BIT control display.	Replace RDDI: ON 163427 THRU 163782 (A1-F18AC-745-300, WP004 00). ON 163985 AND UP (A1-F18AG-745-300, WP004 00).

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data (continued)

Table 1. ALQ-165 (ASPJ) Built-In Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
NOTE If an X is displayed through the ASPJ or ASPJ MAINT pusbutton legends, then ASPJ initiated or maintenance BIT cannot be run for up to 20 minutes without engines running or up to 5 minutes with engines running above 75%.		
d. On RDDI, press and release ASPJ or ASPJ MAINT push-button switch.	1. On ON F/A-18C AND ON F/A-18D 163434 THRU 163778, on LH advisory and threat warning panel, XMIT light flashes on during BIT.	If XMIT light did not flash on and ASPJ BIT status displays GO, do table 1, WP020 00.
	2. On ON F/A-18D 163986 AND UP, on LH advisory and threat warning indicator panel in cockpit, and on rear advisory and threat warning indicator panel in rear cockpit, XMIT light flashes on during BIT.	If XMIT light on one or both advisory and threat warning indicator panels did not flash on and ASPJ BIT status displays GO, do table 2, WP020 00.
	3. ASPJ BIT status displays IN TEST and then displays GO for: WITH DIGITAL DATA COMPUTER CONFIG/IDENT 91C - 30 seconds. WITH DIGITAL DATA COMPUTER CONFIG/IDENT 09C AND UP - 180 seconds.	1. If display is DEGD, read and record maintenance code(s) from nose wheelwell DDI (A1-F18AC-LMM-000) and refer to table 1, WP021 00. 2. If display is NOT RDY, do table 2, WP021 00. 3. If display is RESTRT, press and release STOP pusbutton switch, then press and release ASPJ or ASPJ MAINT push-button switch. If RESTRT is again displayed, replace ALQ-165 Processor (A1-F18AE-760-300, WP012 00). 4. If display is MUX FAIL, read and record maintenance code(s) from nose wheelwell DDI (A1-F18AC-LMM-000) and refer to table 1, WP021 00. 5. If display is OVRHT, do Avionics Cooling System Test (A1-F18AC-410-200, WP014 00).

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data (continued)

Table 1. ALQ-165 (ASPJ) Built-In Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
		6. If display is DEGD+OVRHT, do Avionics Cooling System Test (A1-F18AC-410-200, WP014 00). If test runs good, read and record maintenance code(s) from nose wheelwell DDI (A1-F18AC-LMM-000) and refer to table 1, WP021 00.
e. If MBIT was started and test is complete, press and release STOP pusbutton switch.		
f. At completion of IBIT or MBIT, set ECM mode select switch to OFF.	1. On ON F/A-18C AND ON F/A-18D 163434 THRU 163778, on LH advisory and threat warning indicator panel, all lights are off.	Replace ECM control panel assembly (A1-F18AE-760-300, WP007 00).
	2. On LH advisory and threat warning indicator panel in cockpit, and on rear advisory and threat warning indicator panel in rear cockpit, all lights are off.	
3. FINAL.		
a. On LDDI and RDDI, set power switch to OFF.		
b. Remove electrical power (A1-F18AC-LMM-000).		
c. On nose wheelwell digital display indicator, read, record, and then reset maintenance code display (A1-F18AC-LMM-000).		

Figure A10-1 Example of Procedure/Normal Indication/Remedy Troubleshooting Data (continued)

A2.0 PROCEDURE/NORMAL INDICATION/REMEDY WITH EMBEDDED GRAPHICS

The following is an example of a procedure/normal indication/remedy table with embedded graphics as found in troubleshooting information. This accounted for 18 of our 13,518 pages surveyed.

A1-F18AC-130-200
Change 4

005 00
Page 2

Table 1. MLG Rigging Operational Test

Procedure	Normal Indication	Remedy for Abnormal Indication

System Required Components

All system components installed.

Related Systems Required

Electrical System
Hydraulic System

Support Equipment Required

Part Number or Type Designation	Nomenclature
-	External Electrical Power Source
-	External Hydraulic Power Source
DPPH250	Spring Resiliency Tester
74D110107-1001	MLG Doors Aircraft Ground Safety Pin Set
3221AS121-1	MLG Planing Arm Test Adapter

Materials Required

Specification or Part Number	Nomenclature
-	Tape
MIL-P-8116 (CAGE 81349)	Putty
MS20995NC40 (CAGE 96906)	Lockwire

1. PRELIMINARY.

CAUTION

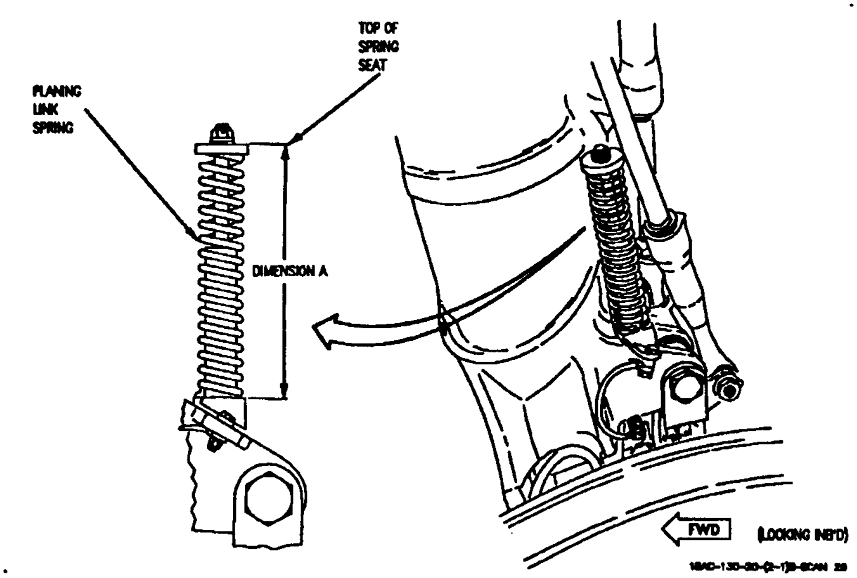
To prevent damage to equipment, MLG shock absorbers must not be overserviced. Over or under inflated MLG tires or MLG shock absorbers which are not correctly serviced may cause interference problems resulting in possible damage when MLG is retracted.

a. Make sure electrical and hydraulic power are off (A1-F18AC-LMM-000).

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
b. Jack aircraft (A1-F18AC-LMM-000).		
c. Install MLG doors aircraft ground safety pin set (A1-F18AC-PCM-000).		
2. MLG RIGGING OPERATIONAL TEST. (QA)		

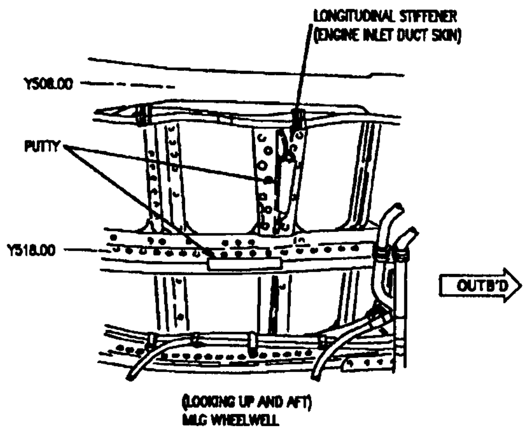


Procedure	Normal Indication	Remedy for Abnormal Indication
a. Measure and record planing link spring dimension A.	Planing link spring dimension A is 6.81 to 6.87 inches	Adjust planing link spring (A1-F18AC-130-300, WP040 01).

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication



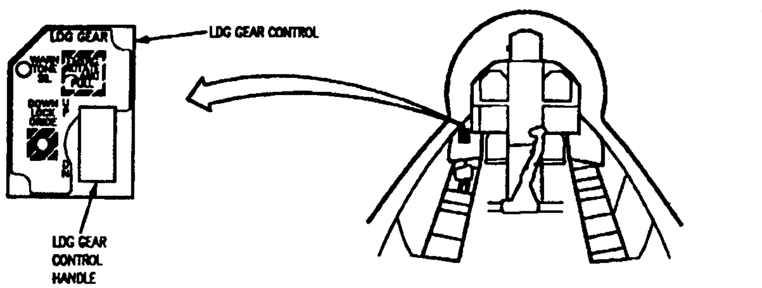
WARNING

Putty is toxic. Wash hands thoroughly prior to eating, drinking, or smoking.

Procedure	Normal Indication	Remedy for Abnormal Indication
b. Apply putty to forward face of Y518 frame and longitudinal stiffener on the engine inlet duct skin.		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)



Procedure	Normal Indication	Remedy for Abnormal Indication
c. On LDG GEAR control, make sure LDG GEAR control handle is set to DN.		
d. Do ground intercommunications hookup with external electrical power (A1-F18AC-LMM-000).		
e. Remove landing gear aircraft ground safety pin from MLG being tested (A1-F18AC-PCM-000).		

WARNING

To prevent death or injury to personnel or damage to equipment, area surrounding MLG must be clear of personnel and obstructions.

CAUTION

To prevent damage to equipment, MLG must be retracted slowly.

Procedure	Normal Indication	Remedy for Abnormal Indication
f. Set LDG GEAR control handle to UP.		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
g. Apply external hydraulic power and slowly increase hydraulic pressure to allow slow retraction of MLG (A1-F18AC-LMM-000). h. When MLG is fully retracted and locked, turn off external electrical and hydraulic power (A1-F18AC-LMM-000).	MLG slowly retracts and locks.	Test for binding in landing gear joints and/or not enough hydraulic pressure to retract actuators because of external source or leakage of actuators.

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
i. Measure and record inboard stowed tire clearance dimension C from centerline of tire to nearest point on MLG wheel emergency stop.		

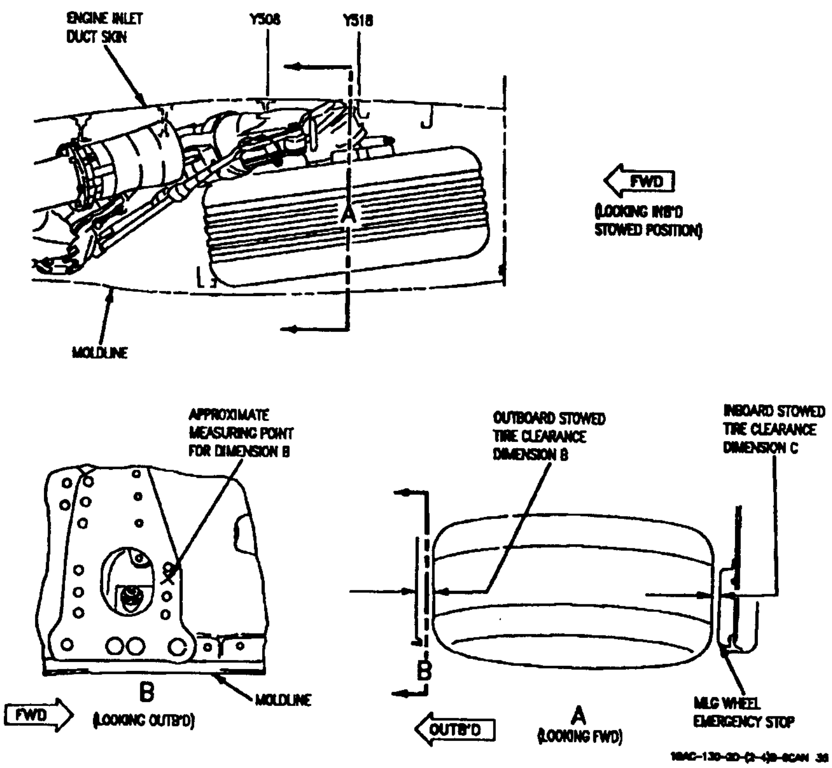


Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
j. To allow for MLG tire passing clearance, subtract 0.25 inch from inboard stowed tire clearance dimension C, recorded in step i, and record this amount.		
k. Measure and record outboard stowed tire clearance dimension B from centerline of tire to nearest point on structure (ignoring rivet heads).		

WARNING

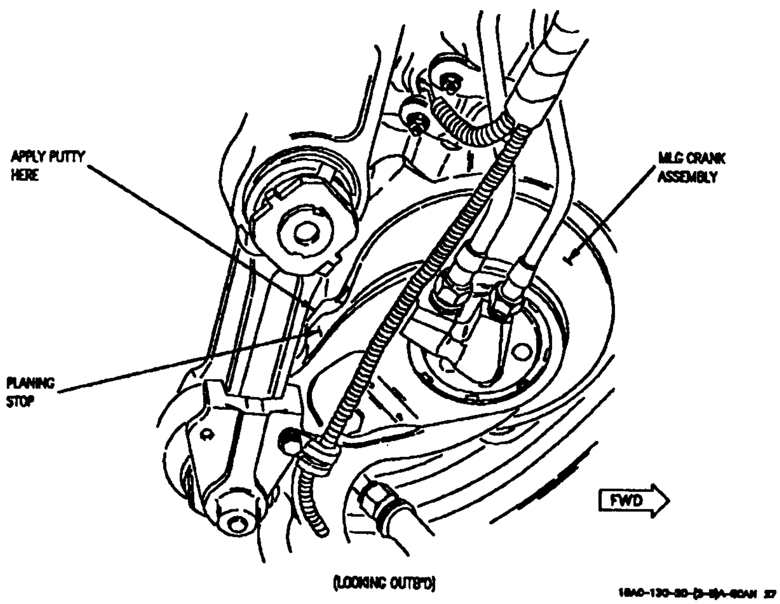
To prevent death or injury to personnel or damage to equipment, area surrounding MLG must be clear of personnel and obstructions.

Procedure	Normal Indication	Remedy for Abnormal Indication
l. Turn on external electrical and hydraulic power (A1-F18AC-LMM-000).		
m. Set LDG GEAR control handle to DN.		
n. When MLG is fully extended and locked, turn off external electrical and hydraulic power (A1-F18AC-LMM-000).		
o. Install landing gear aircraft ground safety pin in MLG (A1-F18AC-PCM-000).		
p. Using inboard stowed tire clearance, recorded in step j, and outboard stowed tire clearance, recorded in step k, determine difference.	Inboard stowed tire clearance and outboard stowed tire clearance are equal within 0.50 inch.	Do MLG planing mechanism assembly rigging (A1-F18AC-130-300, WP044 00).

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
q. Observe putty on Y518 frame and longitudinal stiffener for indications of contact.	No indications of contact exist.	Do MLG planing mechanism assembly rigging (A1-F18AC-130-300, WP044 00).



WARNING

Putty is toxic. Wash hands thoroughly prior to eating, drinking, or smoking.

r. Apply putty to planing stop on MLG crank assembly and apply tape to MLG tire at point tire is opposite moldline of aircraft. Mark tape 0.50 inch inboard and 2.00 inches outboard of centerline of MLG tire.		
s. Turn on external electrical power (A1-F18AC-LMM-000).		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
t. Remove landing gear aircraft ground safety pin from MLG (A1-F18AC-PCM-000).		

WARNING

To prevent death or injury to personnel or damage to equipment, area surrounding MLG must be clear of personnel and obstructions.

CAUTION

To prevent damage to equipment, MLG must be retracted slowly.

Procedure	Normal Indication	Remedy for Abnormal Indication
u. Set LDG GEAR control handle to UP.		

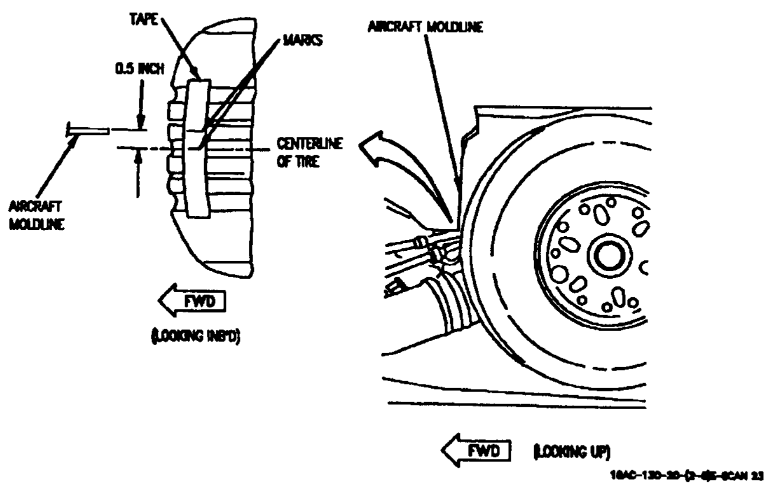


Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
v. Turn on external hydraulic power and slowly increase hydraulic pressure to allow slow retraction of MLG until center of tire is approximately 0.50 inch below aircraft moldline and immediately set LDG GEAR control handle to DN extending MLG (A1-F18AC-LMM-000).		
w. When MLG is fully extended and locked, turn off external electrical and hydraulic power (A1-F18AC-LMM-000).		
x. Install landing gear aircraft ground safety pin in MLG (A1-F18AC-PCM-000).		
y. Observe putty on planing stop for indications of metal to metal contact.	No metal to metal contact exists.	Do MLG planing mechanism assembly rigging (A1-F18AC-130-300, WP044 00).
z. Turn on external electrical power (A1-F18AC-LMM-000).		
aa. Remove landing gear aircraft ground safety pin from MLG (A1-F18AC- PCM-000).		

WARNING

To prevent death or injury to personnel or damage to equipment, area surrounding MLG must be clear of personnel and obstructions.

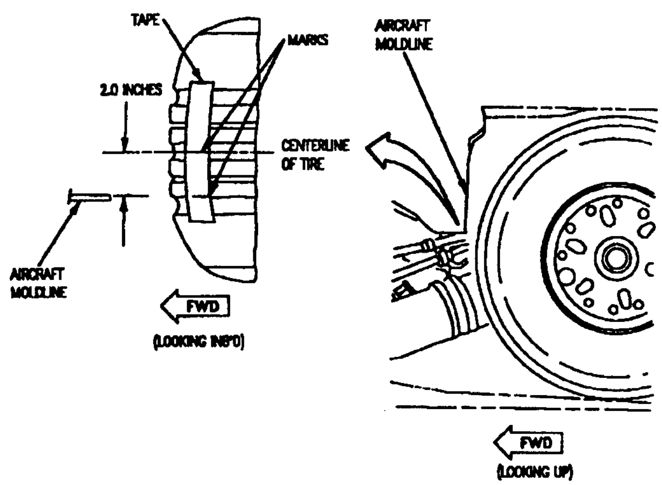
CAUTION

To prevent damage to equipment, MLG must be retracted slowly.

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
ab. Set LDG GEAR control handle to UP.		



Procedure	Normal Indication	Remedy for Abnormal Indication
ac. Turn on external hydraulic power and slowly increase hydraulic pressure to allow slow retraction of MLG until center of tire is approximately 2.00 inches above aircraft moldline and immediately set LDG GEAR control handle to DN extending MLG (A1-F18AC-LMM-000).		
ad. When MLG is fully extended and locked, turn off external electrical and hydraulic power (A1-F18AC-LMM-000).		
ae. Install landing gear aircraft ground safety pin in MLG (A1-F18AC-PCM-000).		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication

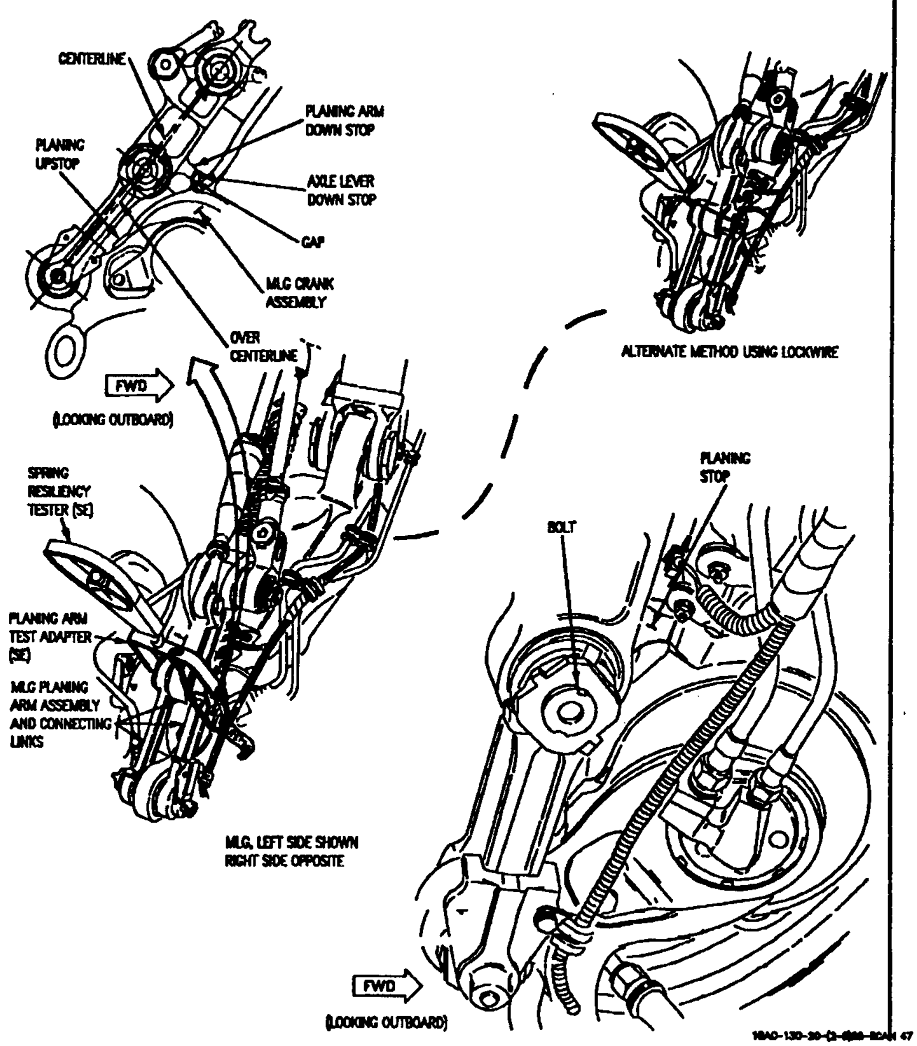


Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
af. Observe putty on planing stop for indications of metal to metal contact.	Indication of metal to metal contact exists.	Do MLG planing mechanism assembly rigging. (A1-F18AC-130-300, WP044 00).
af1. Remove putty from planning stop on MLG crank assembly and tape from MLG tire installed in step r.		
ag. If planing arm test adapter is used to measure overcenter force of the MLG planing arm assembly, do substeps below:		
(1) Attach planing arm test adapter to spring resilency tester DPPH250.		
(2) Place planing arm test adapter over opening in planing arm and connecting links and insert quick release pin.		
ah. If planing arm test adapter is not available, do substeps below:		

WARNING

Lockwire can break causing damage to personnel, aircraft and resiliency tester.

(1) Loop three strands minimum of MS20995NC40 lockwire through hole in center of bolt of MLG planing assembly.		
(2) Connect spring resilency tester DPPH 250 to lockwire.		

NOTE

A minimum pull force is required to raise the MLG planing arm assembly off its down stop on the axle lever.

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

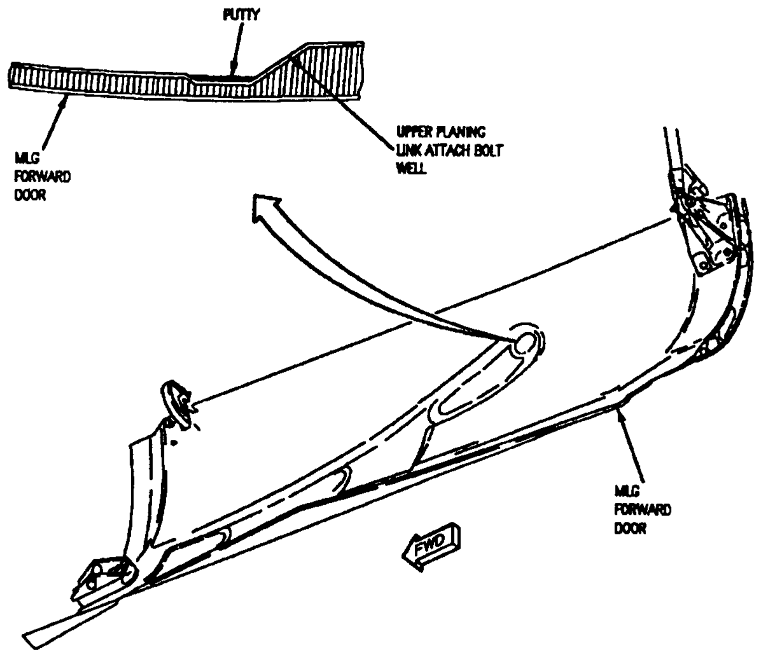
Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
ai. Manually pull on tester perpendicular to planing arm assembly enough to raise MLG planing arm assembly planing stop from making contact. Record minimum tester indication.	Tester indication is 80 pounds minimum for planing arm 74A410538 and 130 pounds minimum for planing arm 74A411720.	Replace planing link (A1-F18AC-130-300, WP043 00).
aj. Release tester.	MLG planing arm assembly planing stop returns and makes contact.	
ak. Disconnect tester, cut and remove lockwire.		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication



WARNING

Putty is toxic. Wash hands thoroughly prior to eating, drinking, or smoking.

Procedure	Normal Indication	Remedy for Abnormal Indication
al. Apply putty to MLG forward door in upper planing link attach bolt well.		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
am. Remove MLG doors aircraft ground safety pin set (A1-F18AC-PCM-000).		
an. Remove landing gear aircraft ground safety pin from MLG (A1-F18AC-PCM-000).		

WARNING

To prevent death or injury to personnel or damage to equipment, area surrounding MLG must be clear of personnel and obstructions.

CAUTION

To prevent damage to equipment, MLG must be retracted slowly.

Procedure	Normal Indication	Remedy for Abnormal Indication
ao. Set LDG GEAR control handle to UP.		
ap. Apply external electrical and hydraulic power and slowly increase hydraulic pressure to allow slow retraction of MLG (A1-F18AC-LMM-000).		
aq. When MLG is fully retracted and locked, and MLG doors closed set LDG GEAR control to DN.		
ar. When MLG is fully extended and locked, turn off external electrical and hydraulic power (A1-F18AC- LMM-000).		
as. Install landing gear aircraft ground safety pin in MLG (A1-F18AC-PCM-000).		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication

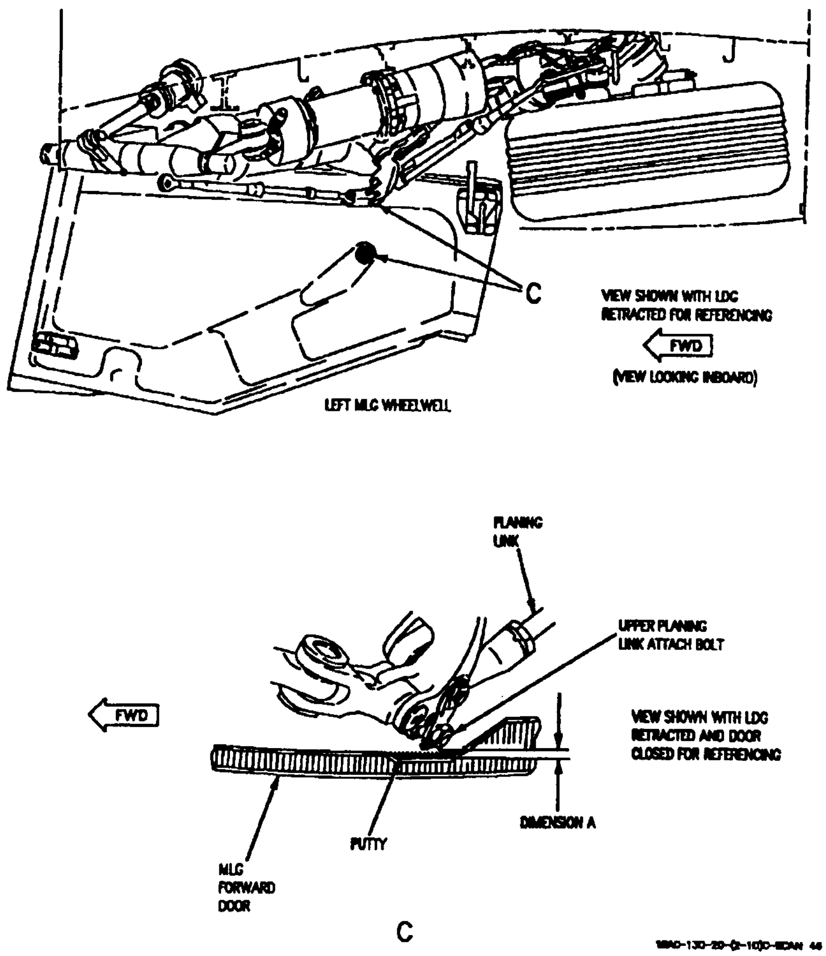


Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

Table 1. MLG Rigging Operational Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
at. Measure dimension A, depth of putty not compressed in MLG forward door by planing link attach bolt.	0.06 inch minimum putty is uncompressed in MLG forward door by planing link attach bolt.	MLG planing link attach bolt contacting MLG forward door. Do MLG axle assembly rigging A1-F18AC-130-300, WP040 02.
au. Remove putty from MLG forward door upper planing link attach bolt well installed in step al.		
av. Do Normal Landing Gear System Operational Test, and Emergency Landing Gear System Operational Test (WP003 00).		

Figure A2.0-1 Example of Procedure/Normal Indication/Remedy With Embedded Graphics Troubleshooting Data (continued)

A3.0 PROCEDURE FAULT/ACTION

The following is an example of a procedure/fault/action table as found in troubleshooting information. This type of table accounted for 549 out of 13, 518 pages surveyed.

NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT

Procedure/Observation	Fault Condition	Action
a. On controller, engage PWR switch.		
b. Engage STAB AUG switch and observe STAB AUG switch remains engaged.	STAB AUG switch does not remain engaged.	Replace controller. If fault persists, check rate gyro, lateral and normal accelerometers, and ADC for faulty operation.
c. On pilot control wheel, press A pushbutton and observe STAB AUG switch disengages.	STAB AUG switch does not disengage.	On copilot control wheel, if STAB AUG switch does not disengage when A pushbutton is pressed, replace controller. If it disengages, replace pilot control wheel.
d. On cockpit CB panel, disengage and engage ELEV-EMERG STOP and ELEV TRIM-STBY HOLD CBs.		

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NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)

Procedure/Observation	Fault Condition	Action
e. On pilot control wheel, move rudder and elevator manual trim switches in four directions and observe that control columns, rudder pedals, and control surfaces follow TPI.	Control columns, rudder pedals, and control surfaces do not follow TPI	If TPI does not indicate trim, check TPI and associated wiring. See NAVAIR 01-E2AAA-2-15.7, figure 17. If fault persists, see NAVAIR 01-E2AAA-2-17.1, figure 2.
f. Repeat step e substituting copilot control wheel.	Control columns, rudder pedals, and control surfaces do not follow TPI.	Proceed to step e action column to resolve fault.
g. On pilot control wheel, operate aileron trim switch and observe aileron and control wheel follow TPI.	Aileron and control wheel do not follow TPI.	Check TPI and associated wiring. See NAVAIR 01-E2AAA-2-15.7, figure 17. If fault persists, replace pilot control wheel.
h. Press T pushbutton, operate rudder and elevator manual trim switches in nose up and nose down, and observe elevator does not deflect.	Elevator does deflect.	Check elevator emergency time relays no. 1, no. 2 and no. 3. If fault persists, replace pilot control wheel.

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NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)

Procedure/Observation	Fault Condition	Action
i. On pilot CB panel, disengage and engage ELEVATOR TRIM-EMERG STOP CB and repeat step h substituting copilot control wheel.	Elevator does not deflect.	Proceed to step h action column to resolve fault.
j. On pilot control wheel, move rudder trim switch and observe that TPI does not move.	TPI moves when rudder trim switch is moved.	Replace trim cutout relay.
k. On controller, rotate FLAT TURN control cw and then ccw and observe rudder and left aileron deflect.	Rudder and left aileron do not deflect.	If neither aileron or rudder deflect, replace air nav computer and/or controller. If only aileron deflects, replace rudder actuator. If only rudder deflects, replace aileron actuator.
l. Set FLAT TURN control to detent.		

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Figure A3.0-1 Example of Procedure Facilitation

NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)		
Procedure/Observation	Fault Condition	Action
m. On trim console panel, set PITCH FEEL AUTO/MAN switch to MAN and observe MANUAL r lamp on advisory lights panel is on.	Manual r lamp does not go on.	Press LIGHTS MASTER TEST switch. If MANUAL r lamp goes on, replace trim console panel. If MANUAL r lamp does not go on, replace lamp on advisory lights panel.
n. On trim console panel, set MAX RUDDER switch from 20° to 8−2° and observe MRPF indicates 8°.	MRPF does not indicate 8°.	Set MAX RUDDER switch to 20°. If MRPF indicates 20°, replace trim console panel. If fault persists, replace ratio change actuator. If MRPF does not indicate 20°, replace resistors associated with MRPF indicator.

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NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)		
Procedure/Observation	Fault Condition	Action
o. Set and hold PITCH FEEL INC/DEC switch to INC until 240 knots and 2° is indicated on MRPF and observe PITCH FEEL and MAX RUDDER lamps on caution lights panel are on.	PITCH FEEL and MAX RUDDER lamps are not on.	If MRPF fails to indicate 240 knots, replace pitch feel "Q" actuator and/or MRPF indicator. If MRPF fails to indicate 2°, replace 2° step actuator. If MRPF does not indicate 240 knots or 2°, replace automatic pitch feel control relay.
p. Set and hold PITCH FEEL INC/DEC switch until maximum knots is indicated on MRPF.		
q. Set MAX RUDDER switch from 20° to 8−2° and observe MAX RUDDER lamp on caution lights panel is off, and after 15 seconds, MRPF indicates more than 300 knots and 2°.	MAX RUDDER lamp is not off, and MRPF does not indicate more than 300 knots and 2°.	Replace rudder warning light time delay relay and/or caution lights panel. If fault persists, replace pitch feel "Q" actuator and/or MRPF indicator.

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NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)		
Procedure/Observation	Fault Condition	Action
r. Set MAX RUDDER switch to 20° and PITCH FEEL AUTO/MAN switch to AUTO and observe control column does not move.	Control column moves.	Replace pitch feel protective relay.
s. On caution lights panel, PITCH FEEL lamp is on.	PITCH FEEL lamp is not on.	Replace "Q" actuator position sensor No. 2. If fault persists, replace air nav computer.
t. On trim console panel, set and hold PITCH FEEL INC/DEC switch to DEC until PITCH FEEL lamp on caution lights panel is off.		
u. Observe control column moves forward and stops.	Control column does not move.	Replace pitch feel control wheel disconnect relay. If fault persists, replace air nav computer.
v. Set PITCH FEEL AUTO/MAN switch to MAN.		

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Figure A3.0-1 Example of Procedure Facilitation (continued)

NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)

Procedure/Observation	Fault Condition	Action
w. Using PITCH FEEL INC/DEC switch, increase pitch feel until PITCH FEEL lamp on caution lights panel goes on.		
x. Decrease PITCH FEEL INC/DEC switch until PITCH FEEL lamp just goes off and observe MRPF indicates between 110 and 120 knots.	MRPF does not indicate between 110 and 120 knots.	Replace "Q" actuator position sensor no. 1. If fault persists, replace air nav computer.
y. Set PITCH FEEL AUTO/MAN switch to AUTO and observe both control columns move forward and MRPF indicates a minimum of 100 knots.	Control columns do not move forward.	Replace pitch feel control wheel disconnect relay. If fault persists, replace air nav computer.

CAUTION

In the following step, when decreasing indication to minimum, do not allow control column to move forward more than one inch.

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NAVAIR 01-E2AAA-2-17.8.2

2. OPERATIONAL CHECKOUT (cont)

Procedure/Observation	Fault Condition	Action
z. Set PITCH FEEL AUTO/MAN switch to MAN and using PITCH FEEL INC/DEC switch, decrease indication on MRPF to minimum.		
aa. Set PITCH FEEL AUTO/MAN switch to AUTO and disengage AFCS and STAB AUG switches on controller.		

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Figure A3.0-1 Example of Procedure Facilitation (continued)

A4.0 PROCEDURE/NO/YES

The following is an example of a procedure/no/yes table as found in troubleshooting information. This type of table accounted for 5,204 out of 13, 518 pages surveyed.

A1-F18AE-760-200 **060 00**
Page 2

Table 1. Right Rear High Band RF Circuit Out of Tolerance

Support Equipment Required

Part Number or Type Designation	Nomenclature
AN/USM-482	Swept Frequency Measurement Test Set
—	Torque Wrench, 0 to 50 Inch-Pounds

Materials Required

Specification or Part Number	Nomenclature
MS20995NC20	Lockwire

NOTE

Right Rear High Band RF Circuit, Figure 1, may be used with this procedure.

For locator, see WP044 00.

Malfunction is caused by one of the items listed below:

Adapter 62CPT035B
ALR-67 coax cable SW435
ALR-67 coax cable SW539
ALR-67 coax cable SW538
ALR-67 coax cable SW425
Right rear antenna-radome
Right rear band pass filter
Right rear radio frequency transmission switch

Procedure	No	Yes
a. Do substeps below:		
(1) Remove electrical power (A1-F18AC-LMM-000).		
(2) Remove right rear antenna-radome (A1-F18AE-760-300, WP044 00).		
(3) Open door 124R (A1-F18AC-LMM-010).		
(4) In door 124R, remove lockwire and disconnect 62P-T025A from J1 on right rear band pass filter.		

Figure A4.0-1 Example of Procedure/No/Yes

Table 1. Right Rear High Band RF Circuit Out of Tolerance (Continued)

Procedure	No	Yes
(5) Use table 3, hookup 1 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		
(6) Does unit under test exceed maximum insertion loss value?	b	k
b. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect 62P-T025B from J2 on right rear band pass filter.		
(2) In door 124R, remove lockwire and disconnect 62P-T011D from J4 on 135° quadrant receiver.		
(3) Use table 3, hookup 2 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		
(4) Does unit under test exceed maximum insertion loss value?	c	f
c. Use table 4, hookup 1 (this work package) and do operating procedures for return loss (NAVAIR 16-30USM482-1). Is return loss measurement less than the minimum allowable return loss value?	e	d
d. Replace right rear band pass filter (A1-F18AE-760-300, WP047 00). Do step q	-	-
e. Replace right rear antenna-radome (A1-F18AE-760-300, WP044 00). Do step q	-	-
f. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect 62P-T035C from J3 on right rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW538.		
(3) Does unit under test exceed maximum insertion loss value?	h	g
g. Replace ALR-67 coax cable SW538 (A1-F18AE-760-300, WP064 00). Do step q	-	-
h. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect 62P-T035D from J4 on right rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW425.		
(3) Does unit under test exceed maximum insertion loss value?	i	j
i. Replace right rear radio frequency transmission switch (A1-F18AE-760-300, WP046 00). Do step q	-	-

Figure A4.0-1 Example of Procedure/No/Yes (continued)

Table 1. Right Rear High Band RF Circuit Out of Tolerance (Continued)

Procedure	No	Yes
j. Inspect connector 62P-T011D for damage. If connector repair is required, do connector repair of cable assembly replaceable front ends (A1-F18A( )- WRM-000). If connector repair is not required, replace ALR-67 coax cable SW425 (A1-F18AE-760-300, WP064 00). Do step q	-	-
k. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect 62P-T035A from J1 on right rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW539.		
(3) Does unit under test exceed maximum insertion loss value?	m	l
l. Replace ALR-67 coax cable SW539 (A1-F18AE-760-300, WP064 00). Do step q	-	-
m. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect adapter 62CPT035B from J2 on right rear radio frequency transmission switch.		
(2) Use table 3, hookup 3 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		
(3) Does unit under test exceed maximum insertion loss value?	i	n
n. Do substeps below:		
(1) In door 124R, remove lockwire and disconnect adapter 62CPT035B from 62P-T035B.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW435.		
(3) Does unit under test exceed maximum insertion loss value?	p	o
o. Replace ALR-67 coax cable SW435 (A1-F18AE-760-300, WP063 00). Do step q	-	-
p. Replace adapter 62CPT035B (A1-F18AE-760-300, WP063 00). Do step q	-	-
q. If disconnected, removed or opened during this procedure, make sure items listed are connected, installed or closed:		
(1) 62P-T011D (torque to 20 to 26 inch pounds, and safety with lockwire)		
(2) 62P-T025A (torque to 20 to 26 inch pounds, and safety with lockwire)		
(3) 62P-T025B (torque to 20 to 26 inch pounds, and safety with lockwire)		

Figure A4.0-1 Example of Procedure/No/Yes (continued)

Table 1. Right Rear High Band RF Circuit Out of Tolerance (Continued)

Procedure	No	Yes
(4) 62P-T035A (torque to 20 to 26 inch pounds, and safety with lockwire)		
(5) 62P-T035B (torque to 20 to 26 inch pounds, and safety with lockwire)		
(6) 62P-T035C (torque to 20 to 26 inch pounds, and safety with lockwire)		
(7) 62P-T035D (torque to 20 to 26 inch pounds, and safety with lockwire)		
(8) Adapter 62CPT035B (torque to 20 to 26 inch pounds, and safety with lockwire)		
(9) Door 124R		
(10) Right rear antenna-radome		

Table 2. Left Forward High Band RF Circuit Out of Tolerance

Support Equipment Required

Part Number or Type Designation	Nomenclature
AN/USM-482	Swept Frequency Measurement Test Set
—	Torque Wrench, 0 to 50 Inch-Pounds

Materials Required

Specification or Part Number	Nomenclature
MS20995NC20	Lockwire

NOTE

Left Rear High Band RF Circuit, Figure 2, may be used with this procedure.

For locator, see WP044 00.

Figure A4.0-1 Example of Procedure/No/Yes (continued)

Table 2. Left Forward High Band RF Circuit Out of Tolerance (Continued)

Malfunction is caused by one of the items below:

Adapter 62CPS036B
ALR-67 coax cable SW435
ALR-67 coax cable SW639
ALR-67 coax cable SW538
ALR-67 coax cable SW425
Left rear antenna-radome
Left rear band pass filter
Left rear radio frequency transmission switch

Procedure	No	Yes
a. Do substeps below:		
(1) Remove electrical power (A1-F18AC-LMM-000).		
(2) Remove left rear antenna-radome (A1-F18AE-760-300, WP044 00).		
(3) Open door 124L (A1-F18AC-LMM-010).		
(4) In door 124L, remove lockwire and disconnect 62P-S026A from J1 on left rear band pass filter.		
(5) Use table 3, hookup 4 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		
(6) Does unit under test exceed maximum insertion loss value?	b	k
b. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect 62P-S026B from J2 on left rear band pass filter.		
(2) In door 124L, remove lockwire and disconnect 62P-S012D from J4 on 225° quadrant receiver.		
(3) Use table 3, hookup 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		
(4) Does unit under test exceed maximum insertion loss value?	c	f
c. Use table 4, hookup 2 (this work package) and do operating procedures for return loss (NAVAIR 16-30USM482-1). Is return loss measurement less than the minimum allowable return loss value?	e	d
d. Replace left rear band pass filter (A1-F18AE-760-300, WP047 00). Do step q.	-	-
e. Replace left rear antenna-radome (A1-F18AE-760-300, WP044 00). Do step q.	-	-

Figure A4.0-1 Example of Procedure/No/Yes (continued)

Table 2. Left Forward High Band RF Circuit Out of Tolerance (Continued)

Procedure	No	Yes
f. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect 62P-S036C from J3 on left rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW538.		
(3) Does unit under test exceed maximum insertion loss value?	h	g
g. Replace ALR-67 coax cable SW538 (A1-F18AE-760-300, WP064 00). Do step q	-	-
h. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect 62P-S036D from J4 on left rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW425.		
(3) Does unit under test exceed maximum insertion loss value?	i	j
i. Replace left rear radio frequency transmission switch (A1-F18AE-760-300, WP040 00). Do step q	-	-
j. Inspect connector 62P-S012D for damage. If connector repair is required, do connector repair of cable assembly replaceable front ends (A1-F18A( )-WRM-000). If connector repair is not required, replace ALR-67 coax cable SW425 (A1-F18AE-760-300, WP064 00). Do step q	-	-
k. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect 62P-S036A from J1 on left rear radio frequency transmission switch.		
(2) Use table 5 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW539.		
(4) Does unit under test exceed maximum insertion loss value?	m	l
l. Replace ALR-67 coax cable SW539 (A1-F18AE-760-300, WP064 00). Do step q	-	-
m. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect adapter 62CPS036B from J2 on left rear radio frequency transmission switch.		
(2) Use table 3, hookup 6 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1).		

Figure A4.0-1 Example of Procedure/No/Yes (continued)

Table 2. Left Forward High Band RF Circuit Out of Tolerance (Continued)

Procedure	No	Yes
(3) Does unit under test exceed maximum insertion loss value?	i	n
n. Do substeps below:		
(1) In door 124L, remove lockwire and disconnect adapter 62CPS036B from 62P-S036B.		
(2) Use table 6 (this work package) and do operating procedures for insertion loss (NAVAIR 16-30USM482-1) on ALR-67 coax cable SW435.		
(3) Does unit under test exceed maximum insertion loss value?	p	o
o. Replace ALR-67 coax cable SW435 (A1-F18AE-760-300, WP063 00). Do step q	-	-
p. Replace adapter 62CPS036B (A1-F18AE-760-300, WP063 00). Do step q	-	-
q. If disconnected, removed or opened during this procedure, make sure items listed are connected, installed or closed:		
(1) 62P-S012D (torque to 20 to 26 inch pounds, and safety with lockwire)		
(2) 62P-S026A (torque to 20 to 26 inch pounds, and safety with lockwire)		
(3) 62P-S026B (torque to 20 to 26 inch pounds, and safety with lockwire)		
(4) 62P-S036A (torque to 20 to 26 inch pounds, and safety with lockwire)		
(5) 62P-S036B (torque to 20 to 26 inch pounds, and safety with lockwire)		
(6) 62P-S036C (torque to 20 to 26 inch pounds, and safety with lockwire)		
(7) 62P-S036D (torque to 20 to 26 inch pounds, and safety with lockwire)		
(8) Adapter 62CPS036B (torque to 20 to 26 inch pounds, and safety with lockwire)		
(9) Door 124L		
(10) Left rear antenna-radome	-	-

Figure A4.0-1 Example of Procedure/No/Yes (continued)

A5.0 PROCEDURE/NO/YES VARIATION

The following is an example of a procedure/no/yes variation table as found in troubleshooting information. This type of table accounted for 5,204 out of 13, 518 pages surveyed.

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14. SENSO Console Light Dimmer Troubleshooting Test.

NOTE

This troubleshooting procedure is used to supplement SENSO Console Lighting Troubleshooting Test. (SWP 02.)

a. Open and tag SENSO CSL LT DMR ϕB circuit breaker on left hinged circuit breaker panel.

b. Disconnect P728 from SENSO console light dimmer (FO-8).

c. Connect P1 plug connector of W1-1308589-101 adapter cable (part of 1307635-101 Cable Set) to dimmer and J1 receptacle to P728 (Figure 2).

d. Connect P62 to J62 receptacle of breakout box.

e. Proceed to Table 9 and perform troubleshooting procedure.

Table 9 SENSO CONSOLE LIGHT DIMMER TROUBLESHOOTING TEST

Test	Action for Yes	Action for No
1a. Install a jumper (part of breakout box) between J1 and J2 receptacles. Install a second jumper between J3 and J4 receptacles (Figure 10). Remove tag and close SENSO CSL LT DMR ϕB circuit breaker on left hinged circuit breaker panel. With multimeter test leads, probe receptacles and observe output voltages as follows: J12–J14 5.0(±0.5)Vac J15–J16 5.0(±0.5)Vac J26–J28 5.0(±0.5)Vac Are all output voltages present?	1b. Disconnect multimeter from breakout box. Install jumpers between J5 and J6, J7 and J8, J11 and J12, and J13 and J14 receptacles. Proceed to step 2a.	1c. With multimeter, measure voltage between J1 and J3 receptacles. If voltage is 115 Vac, Replace SENSO console light dimmer (NAVAIR 01-S3B-2-4.11 WP 008 00). If voltage is not 115 Vac troubleshoot aircraft wiring between SENSO CSL LT DMR ϕB circuit breaker and P728 (NAVAIR 01-S3B-2-5.1 SWP 012 11).
2a. On SENSO INTERIOR LIGHTS panel, set CHECK LIST MISCL switch to ON. Turn CONSOLE control slowly to BRT. Verify that the following panel lights come on and increase in brightness. Auxiliary display (ARU) Check list Multipurpose display (SENSO) SONO MON TIME CODE GENERATOR Do all panel lights come on?	2b. On SENSO INTERIOR LIGHTS panel, turn CONSOLE control to OFF. Lights dim, then go off. Proceed to step 3a.	2c. Troubleshoot dimmer output circuit No. 1 (Figure 10 and NAVAIR 01-S3B-2-5.1 SWP 012 11).
3a. Do panel lights dim?	3b. Remove jumpers from J11, J12, J13, and J14 receptacles. Install jumpers between J15 and J16, and J17 and J18 receptacles. Proceed to step 4a.	3c. Perform step 1c.

Figure A5.0-1 Example of Procedure/No/Yes Variation

Table 9 SENSO CONSOLE LIGHT DIMMER TROUBLESHOOTING TEST (CONT.)

	Test		Action for Yes		Action for No
4a.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control slowly to BRT. Verify that the following panel lights come on and increase in brightness. CREW ICS INTERIOR LIGHTS OXYGEN SEAT/MIKE SELECT Do all panel lights come on?	4b.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control to OFF. Remove jumpers from J15, J16, J17, and J18 receptacles. Install jumpers between J25 and J26, and J27 and J28 receptacles. Proceed to step 5a.	4c.	Troubleshoot dimmer output circuit No. 2 (Figure 10 and NAVAIR 01-S3B-2-5.1 SWP 012 11).
5a.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control slowly to BRT. Verify that the following panel lights come on and increase in brightness. TAPE RECORDER REMOTE CONTROL Do all panel lights come on?	5b.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control to OFF. Remove jumpers from J25, J26, J27, and J28 receptacles. Install jumpers between J21 and J22, and J23 and J24 receptacles. Proceed to step 6a.	5c.	Troubleshoot dimmer output circuit No. 3 (Figure 10 and NAVAIR 01-S3B-2-5.1 SWP 012 11).
6a.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control slowly to BRT. Verify that the MAGNETIC COMPENSATOR panel light comes on. Does the panel light come on?	6b.	Open and tag SENSO CSL LT DMR φB circuit breaker on left hinged circuit breaker panel. Disconnect and stow test equipment. Connect P728. Proceed to step 7a.	6c.	Troubleshoot dimmer 28 Vac output circuit (Figure 10 and NAVAIR 01-S3B-2-5.1 SWP 012 11).
7a.	Remove tag and close SENSO CSL LT DMR φB circuit breaker on left hinged circuit breaker panel. On SENSO INTERIOR LIGHTS panel, turn CONSOLE control slowly to BRT. Verify that CGA panel light comes on and increases in brightness. Does panel light come on?	7b.	No fault indicated. Open and tag SENSO CSL LT DMR φB circuit breaker on left hinged circuit breaker panel. Install trim panel (NAVAIR 01-S3B-2-4.11 WP 008 00).	7c.	Perform step 8a.

Figure A5.0-1 Example of Procedure/No/Yes Variation (continued)

Table 9 SENSO CONSOLE LIGHT DIMMER TROUBLESHOOTING TEST (CONT.)

	Test		Action for Yes		Action for No
8a.	On SENSO INTERIOR LIGHTS panel, turn CONSOLE control to OFF. Remove magnetic field indicator (NAVAIR 01–S3B–2–4.14 WP 008 00) from SENSO instrument panel and disconnect P3005. Measure voltage between pins 73 and 80 of P3005, as CONSOLE control is turned to BRT. Is voltage 5.0 (±0.5) Vac?	8b.	Replace magnetic field indicator (NAVAIR 01–S3B–2–4.14 WP 008 00).	8c.	Troubleshoot dimmer output circuit No. 1 from plug connector P728 to P3005 (Figure 10 and NAVAIR 01–S3B–2–5.1 SWP 012 11).

Figure A5.0-1 Example of Procedure/No/Yes Variation (continued)

A6.0 STEP/PROCEDURE/RESULT

The following is an example of a step/procedure/result as found in troubleshooting information. This type of page accounted for 265 out of 13, 518 pages surveyed.

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TABLE 9. ROCKET/DISPENSER RELEASE CHECK (CONT)

Step	Location	Switch/Item	Position/Action	Indication
18	ACP	STATION SELECT W5 and W6	Press and release	STATION SELECT lights green. MSTR ARM light on
19	LC	MASTER ARM	OFF	MSTR ARM light off

25. MECHANICAL ARMING CHECK.

26. Accomplish mechanical arming check as follows:

a. Ensure aircraft preparation procedures are completed per Aircraft Preparation paragraph.

b. Tape the store sensing switch on stations W5 and W6 in the up position (loaded) (figure 45).

c. Cock BRU-14/A release unit.

d. Cock and latch all suspension hooks.

e. Proceed to table 10 (figure 49).

27. SINGLE RELEASE SYSTEM CHECK.

28. Accomplish single release system check as follows:

a. Ensure aircraft preparation procedures are completed. (Refer to Aircraft Preparation paragraph.)

b. Tape the store sensing switch at stations W5 and W6 in the up position (loaded) (figure 49).

c. Connect AN/AWM-67 Test Set per figure 46.

d. Cock BRU-14/A release unit.

e. Cock and latch all suspension hooks.

f. Set test set MAIN POWER to ACFT SYSTEM, set MEMORY to RESET, then ON.

g. Set ARMAMENT CONTROL panel WPN to desired bomb, mine, or torpedo.

h. Energize aircraft. Proceed to table 11.

TABLE 10. MECHANICAL ARMING CHECK

Check Step	Procedure	Result
1	Press and release AUTO/MAN switch on ARMAMENT CONTROL panel (ACP)	MAN switch light comes on, AUTO switch light goes off
2	Position MASTER ARM switch to ON	
3	Actuate and release KILL SAFETY DISABLE switch	MSTR ARM cue light comes on
4	Press and release STATION SELECT switch station to be checked	STATION SELECT switch light comes on white ARM SET switch light comes on MSTR ARM cue light goes off
5	Set MECH ARM switch to N/T	

Figure A6.0-1 Example of Step/Procedure/Result

TABLE 10. MECHANICAL ARMING CHECK (CONT)

Check Step	Procedure	Result
	NOTE Check all racks in bomb bay as all racks arm simultaneously. Wing station racks W5 and W6 do not arm simultaneously.	
6	Press and release ARM SET switch	ARM SET switch light goes off
		STATION SELECT switch light comes on amber
		Nose and tail arming solenoids are energized
7	Press and release ARM SET switch	ARM SET switch light comes on
		STATION SELECT switch light comes on white
		Nose and tail arming solenoids are deenergized
8	Set MECH ARM switch to NOSE	
9	Press and release ARM SET switch	ARM SET switch light goes off
		STATION SELECT switch light comes on amber
		Nose arming solenoids are energized, tail arming solenoids are deenergized
10	Press and release ARM SET switch	ARM SET switch light comes on
		STATION SELECT switch light comes on white
11	Set MECH ARM switch to TAIL	
12	Press and release ARM SET switch	ARM SET switch light goes off
		STATION SELECT switch light comes on amber
		Tail arming solenoids are energized, nose arming solenoids are deenergized
13	Press and release ARM SET switch	ARM SET switch light comes on

Figure A6.0-1 Example of Step/Procedure/Result (continued)

TABLE 10. MECHANICAL ARMING CHECK (CONT)

Check Step	Procedure	Result
		STATION SELECT switch light comes on white
14	Set MECH ARM switch to SAFE	
15	Press and release ARM SET switch	ARM SET switch light goes off
		STATION SELECT switch light comes on amber
		Nose and tail arming solenoids are deenergized
16	Press and release STATION SELECT switch for station under check	STATION SELECT switch comes on green
		MSTR ARM cue light comes on
17	Repeat steps 2 through 16 for each wing station to be checked	
18	Position MASTER ARM switch to OFF.	MSTR ARM cue light goes off
19	Press and release AUTO/MAN switch	AUTO switch light comes on, MAN switch light goes off
20	If no other checks are required, perform postcheck procedures. (Refer to Postcheck Procedures paragraph.)	

TABLE 11. SINGLE RELEASE SYSTEM CHECK

Check Step	Procedure	Result
1	Press and release AUTO/MAN switch on ARMAMENT CONTROL panel (ACP)	MAN switch light comes on, AUTO switch goes off
2	Position MASTER ARM switch to ON	
3	Actuate and release KILL SAFETY DISABLE switch	MSTR ARM cue light comes on

NOTE

If wing stations only are to be loaded, proceed to step 20.

Figure A6.0-1 Example of Step/Procedure/Result (continued)

A7.0 STEP/PROCEDURE/RESULT VARIATION

The following is an example of a variation of the step/procedure/result table as found in troubleshooting information. This type of table accounted for 265 out of 13, 518 pages surveyed.

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Page 2

4. A test summary of the turn-on test is provided in table 1 and used as an abbreviated guide for maintenance personnel already initiated in fault-isolation. The test summary table is divided into two sections: operator commands and equipment responses. If a fault condition is detected, it will be necessary to perform the detailed turn-on test procedure to isolate the fault. The test summary consists of the following:

a. Pretest Setup.

b. Turn-On Test.

c. BITE Verification Test.

d. Mode/Option Test.

e. Test Target and Video Test.

5. Expanded testing and troubleshooting step-by-step procedures enable isolation to the proper WRA or radar interface.

6. Several BITE sensors are incorporated in the radar design that are associated with WRAs involved in this test. If any of these BITE sensors indicate a fault, the radar is not ready for use or some part has failed that will prevent the successful completion of the test. To aid the technician in fault-isolation, refer to BITE equations in SWP036 01.

TABLE 1. TURN ON TEST SUMMARY

	Operator Commands			Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
1.	Pretest Setup					
	WARNING Ensure that general maintenance procedures and precautions have been performed before beginning test procedure. **CAUTION** Ensure that vapor cycle system is operational. If vapor cycle system is inoperative, connect external cooling air (NAVAIR 01-E2AAA-2-1, WP029 00). Do not proceed until COOLING AIR TEMP gage on vapor cycle control panel indicates less than 65°F.					
			Perform pretest setup (SWP036 02)			
2.	Turn-On Test					
a.	PROCESSOR PWR CONTROL	CMPTR/SCRAM ON/OFF	Set to ON			None
b.		CIS SYS TRIG NORM/ALTR	Set to NORM		OFF	None
c.		IFPM ON/OFF	Set to ON			None

Figure A7.0-1 Example of Step/Procedure/Result Variation

TABLE 1. TURN ON TEST SUMMARY (cont)						
Operator Commands				Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
d.		DVOM/SCOPE ON/OFF	Set to ON			None
e.	DVOM	POWER/OFF	Set to POWER	DVOM	Display	Lit
f.		MODE	Set to REMOTE			None
g.		RANGE	Set to AUTO			None
h.	ANTENNA SIMULATOR	ON	Press	ANTENNA SIMULATOR	ON	Lit
i.	RO UMD	IND PWR/ON	Press	RO UMD	IND PWR ON	Brightly lit
					IND PWR OFF	Off
					TEST INITIATE DEFL AMPL	Brightly lit
j.	RO UMD	TEST INITIATE-DEFL AMPL	Press	RO UMD	TEST INITIATE-DEFL AMPL	Dimly lit
					FAILURE UMD, EMDU, ADU, and MPS	Off
					OVERHEAT UMD, EMDU, ADU, and MPS	Off
k.	RO UMD VIDEO INT-RADAR	SYNTH	Rotate fully clockwise			None
l.		SP	Rotate fully clockwise			None
m.		AMTI	Rotate fully clockwise			None
n.	ACU	ANT AZ SOURCE	Set to RO	ACU	ANT AZ SOURCE	Displays RO

Figure A7.0-1 Example of Step/Procedure/Result Variation (continued)

TABLE 1. TURN ON TEST SUMMARY (cont)

Operator Commands				Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
o.	WRA 11	ON	Press	WRA 11	ON	Brightly lit
					OFF	Remains brightly lit for 10 minutes, then dimly lit
					STBY/OVLD	STBY dimly lit; OVLD off
					OPR	Dimly lit
p.		CHAN	Set to 6			None
q.		MODE	Set to NORM	WRA 11	ANT ROT OFF/ ON/ALTN	Set to OFF
r.		DUM LOAD	Press	WRA 11	DUM LOAD	Brightly lit
					ANT	Dimly lit
					DPCA	Brightly lit
					ECCM	Off
					TACCAR/SYN	TACCAR brightly lit; SYN off
					TACCAR TEST/ LOOP LOCK	TACCAR TEST dimly lit; LOOP LOCK off
s.		DPCA	Press	WRA 11	DPCA	Dimly lit
t.		LG PULSE GAIN	Rotate fully clockwise			None
u.		LG PULSE STC LEVEL	Rotate fully counter-clockwise			None
v.		TEST TARGET CONTROL TENS and UNITS	Set to 0			None

Figure A7.0-1 Example of Step/Procedure/Result Variation (continued)

TABLE 1. TURN ON TEST SUMMARY (cont)

	Operator Commands			Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
w.	EMDU VIDEO	RADAR SWEEP	Rotate clockwise	EMDU	Display	Sweep is discernible
x.		RADAR LEVEL	Rotate fully clockwise			None
y.	EMDU CONTROL SELECT	VTR ADJ	Press	EMDU	Display	VTR ADJ window appears
z	EMDU DEK	MASTER CONTROL	Adjust	EMDU	Display	Select VTR range
aa.	EMDU CONTROL SELECT	VTR	Press			None
ab.	EMDU DEK	MASTER CONTROL	Adjust	EMDU	Display	VTR is at 250 nmi
ac.	EMDU RANGE	300	Press	EMDU RANGE	300 legend	Brightly lit
ad.	COMPUTER CONTROL	Thumbwheel switches	Set to tactical test tape numbers			None
ae.		PROGRAM LOAD	Press	COMPUTER CONTROL	Computer display and selected thumbwheel numbers	Numbers on computer display and thumbwheel are the same at completion of program load
				EMDU	Display	L-304 program text data (pattern) appears
af.	ACU	COMPT CLEAR	Press	EMDU	Display	Test pattern disappears
ag.	ADU alert	SYMBOL INT	Rotate clockwise	ADU	Display	Legends become visible

Figure A7.0-1 Example of Step/Procedure/Result Variation (continued)

TABLE 1. TURN ON TEST SUMMARY (cont)

	Operator Commands			Equipment Responses		
Step	Subsystem/ Panel	Control/Indicator	Action	Subsystem/ Panel	Control/Indicator	Action
ah.		GRATICULE INT	Rotate clockwise	ADU	Display	Graticule lines become visible
ai.	EMDU	LPHM	Press on display	EMDU	Display	Point appears where LPHM placed
aj.	ADU alert	IFPM ALERT	Observe	ADU alert	IFPM ALERT	Blinking (when a fault exists or during update)
ak.		IFPM ALERT	Press	ADU alert	IFPM ALERT	Remains dimly lit
al.	ADU CAT & FUNCT	RETURN	Press			None
am.		SYSTEM MGMNT 1	Select			None
		IFPM FCTN 2	Select			None
		Note: Push-switch may have to be pressed several times to read entire RADAR STATUS file.				
an.		RADAR STATUS	Select	ADU	Display	On RADAR STATUS file, AF: DIG DATA BUS: 53 registered
ao.				ADU alert	IFPM ALERT	Off
		Note: WRA 53 requires several scans to complete its initialization diagnostics.				
ap.	PROCESSOR PWR CONTROL	RDR PROC ON/OFF	Set to ON	EMDU	Display	Sweep length shall represent medium PRF. Sweep length shall be between 273 and 283 nmi

Figure A7.0-1 Example of Step/Procedure/Result Variation (continued)

A8.0 STEP/PROCEDURE/RESULT WITH EMBEDDED GRAPHICS

The following is an example of a step/procedure/result with embedded graphics as found in troubleshooting information. This type of page accounted for 19 out of 13, 518 pages surveyed.

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g. (As applicable) Install ROCKET/TER harness on aircraft (figure 51).

h. Remove tape from stores sensing switches.

i. Position armament switches to OFF or SAFE on C8787 AMAC control panel (figure 53).

j. (If applicable) Ensure DROP-HOLD switch on ARMAMENT CONTROL panel is positioned to HOLD and that seal wire with seal is installed (figure 53).

k. (If applicable) Ensure the AMAC OS/SA lever is in the OS position and that seal wire with seal is installed (figure 53).

l. Screw breech caps and AUX connectors on breech chambers fingertight.

m. Secure all access panels.

20. JETTISON SYSTEM CHECK.

21. Accomplish Jettison system check as follows:

a. Ensure aircraft preparation procedures are completed. (Refer to Aircraft Preparation paragraph.)

b. Tape the store sensing switch on stations W5 and W6 in the up position (loaded) (figure 45).

c. Connect AN/AWM-67(V) Test Set per figures 46 and 47.

d. Cock BRU-14/A release unit. (Refer to NAVAIR 01-S3AAA-75.)

e. Cock and latch all suspension hooks. (Refer to NAVAIR 01-S3AAA-75.)

22. Proceed to table 7.

23. JETTISON AND RELEASE SYSTEM CHECK-ROCKET/DISPENSER ON PYLONS.

a. Install dispenser/launcher harness to wing pylon connector and connect bail wire to bail rod. Set ACP for appropriate weapon.

b. Connect AN/AWM-67(V) Test Set per figures 45 and 47.

c. Perform jettison system check per table 7 with the following exceptions; steps 5, 8 and 20; release point (RP) 8 shall remain blank.

24. Perform Rocket/Dispenser Release System check per table 9.

TABLE 7. JETTISON SYSTEM CHECK

Step	Location	Switch/Item	Position/Action	Indication
1	TS	MAIN POWER	ACFT SYSTEM MAIN POWER	Lamp on
2	TS	MEMORY	RESET then ON	
		MODE	SYSTEM-RKT	
2A	ACP	WPN (ALL)	Any bomb/mine	
3	CC	EXT PWR	RESET then ON	
4	RCB	SAFETY DISABLE SAR & JTSN	Actuate and hold	

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics

TABLE 7. JETTISON SYSTEM CHECK (CONT)

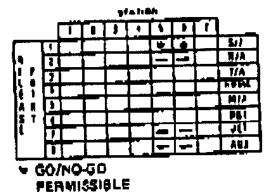
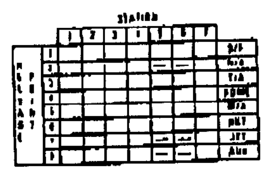
Step	Location	Switch/Item	Position/Action	Indication
5	LC	EXT JETT	Press and release	
6	TS	MEMORY	RESET then ON	Display blank
7	TS	READOUT STATION RP	PW (ms) 5 7	
8	LC	EXT JETT	Press and release	
9	TS	READOUT		800 to 1200
10	RC	SAFETY DISABLE SAR & JTSN	Release	-
11	TS	MEMORY READOUT	RESET then ON OFF	Display blank
12	LC	EXT JETT	Press and release	Display blank
12A	TS	MEMORY	RESET then OFF	
13	ACP	AUTO/MAN	Press and release	AUTO off, MAN on
14	ACP	AUX	W5S	

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

TABLE 7. JETTISON SYSTEM CHECK (CONT)

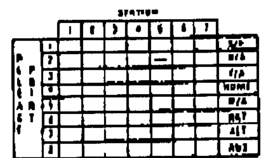
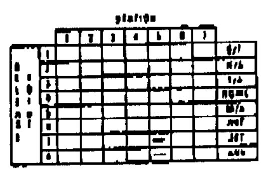
Step	Location	Switch/Item	Position/Action	Indication
15	LC RCP	MASTER ARM KILL SAFETY DISABLE	ON Actuate and release	MSTR ARM light indicator on
15A	TS	MEMORY	RESET then ON	
16	ACP	UNLK	Press and release	 NOTE: GO & NO-GO PERMISSIBLE
17	TS	MEMORY	RESET then ON	Display blank
18	ACP	STATION SELECT W5	Press and release	MSTR ARM light indicator off. STATION SELECT switch light white ARM SET switch light on UNLK switch light off S. JETT switch light on
19	ACP	ARM SET	Press and release	ARM SET switch light off. STATION SELECT switch light amber
20	ACP	S. JETT	Press and release	
21	TS	MEMORY	RESET then ON	Display blank
22	ACP	AUX	W5F	S. JETT switch light on

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

TABLE 7. JETTISON SYSTEM CHECK (CONT)

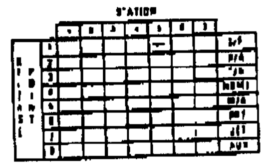
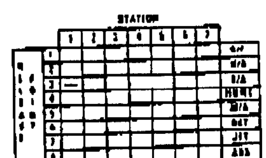
Step	Location	Switch/Item	Position/Action	Indication
23	ACP	S. JETT	Press and release	
24	TS	MEMORY	RESET then ON	Display blank
25	ACP	STATION SELECT W5	Press and release	STATION SELECT Switch light green
26	ACP	AUX	OFF	MSTR ARM light indicator on
27	ACP	S. JETT/UNLK	Press and release	Display blank
28	LC	MASTER ARM	OFF then ON	MSTR ARM light indicator off
29	ACP	S. JETT/UNLK	Press and release	Display blank
30	LC	MASTER ARM OFF		
31	Repeat steps 13 through 30 for STATION 6 (W6S, W6F)			
32	LC	MASTER ARM	ON	
33	RCP	KILL SAFETY DISABLE	Actuate and release	MSTR ARM light indicator on
34	ACP	AUTO/MAN	Press and release as required	MAN on AUTO off
35	ACP	AUX	31	UNLK switch light on
36	ACP	UNLK	Press and release	 NOTE: GO & NO-GO PERMISSIBLE

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

TABLE 7. JETTISON SYSTEM CHECK (CONT)

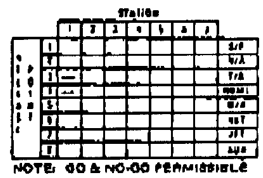
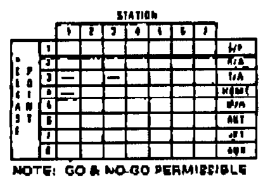
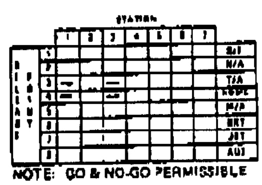
Step	Location	Switch/Item	Position/Action	Indication
37	ACP	AUX	B2	UNLK switch light on
38	ACP	UNLK	Press and release	
38A	ACP	AUX	B3	
38B	ACP	UNLK	Press and release	
39	ACP	AUX	B4	UNLK switch light on
40	ACP	UNLK	Press and release	
41	TS	MEMORY	RESET then ON	Display blank

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

TABLE 7. JETTISON SYSTEM CHECK (CONT)

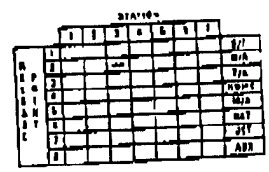
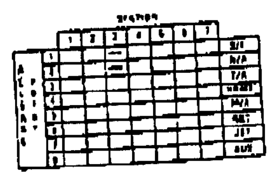
Step	Location	Switch/Item	Position/Action	Indication
42	ACP	STATION SELECT B4	Press and release	STATION SELECT switch light while MSTR ARM light indicator off. UNLK switch light off. S. JETT switch light on. ARM SET switch light on
43	ACP	ARM SET	Press and release	ARM SET switch light out. STATION SELECT switch light amber
44	ACP	S. JETT	Press and release	
45	ACP	STATION SELECT B4	Press and release	STATION SELECT switch light green
46	Repeat steps 42 through 45 for B3			

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

TABLE 7. JETTISON SYSTEM CHECK (CONT)

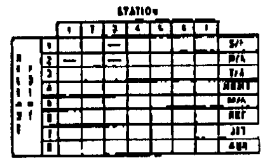
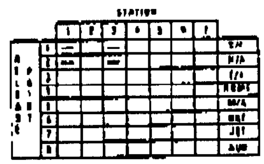
Step	Location	Switch/Item	Position/Action	Indication
47	Repeat steps 42 through 45 for B2			
48	Repeat steps 42 through 45 for B1			
49	TS	MEMORY	RESET then ON	Display blank
50	ACP	AUX	OFF	
51	ACP	S. JETT/AUX	Press and release	Display remains blank
52	ACP	AUTO/MAN	Press and release	Display remains blank. MAN switch light out. AUTO switch light on
53	LC	MASTER ARM	OFF	MSTR ARM indicator off

TABLE 8. ROCKET JETTISON

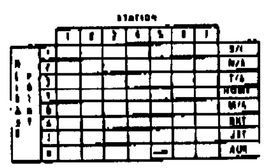
Step	Location	Switch/Item	Position/Action	Indication
1	ACP	AUX	W5M	

Figure A8.0-1 Example of Step/Procedure/Result With Embedded Graphics (continued)

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A9.0 DECISION TREE

The following is an example of a graphical decision tree as found in troubleshooting information. This type of page accounted for 549 out of 13, 518 pages surveyed.

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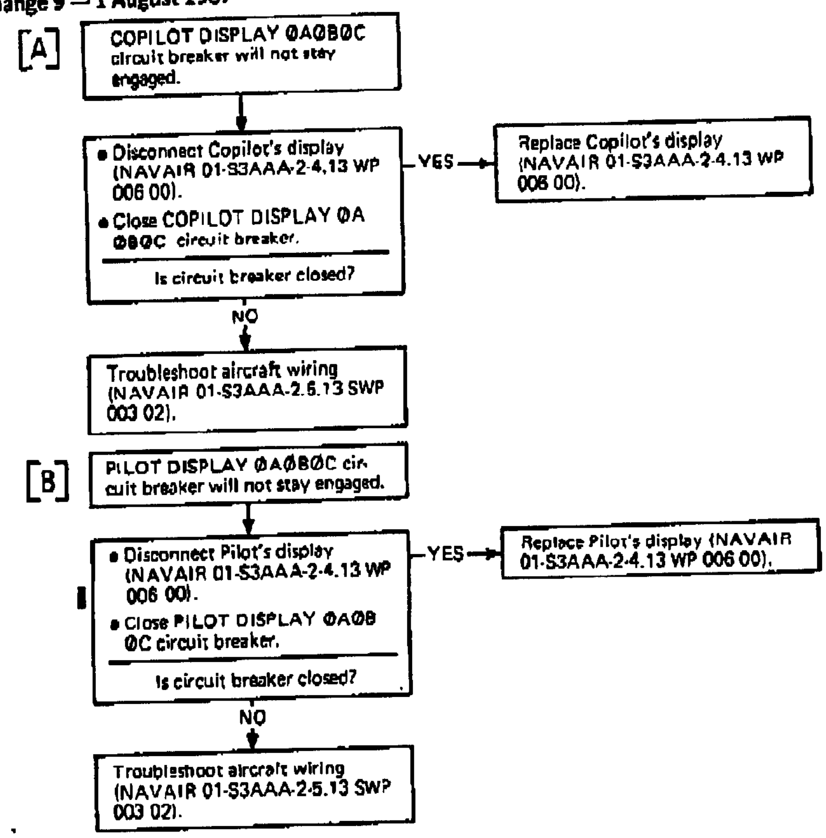
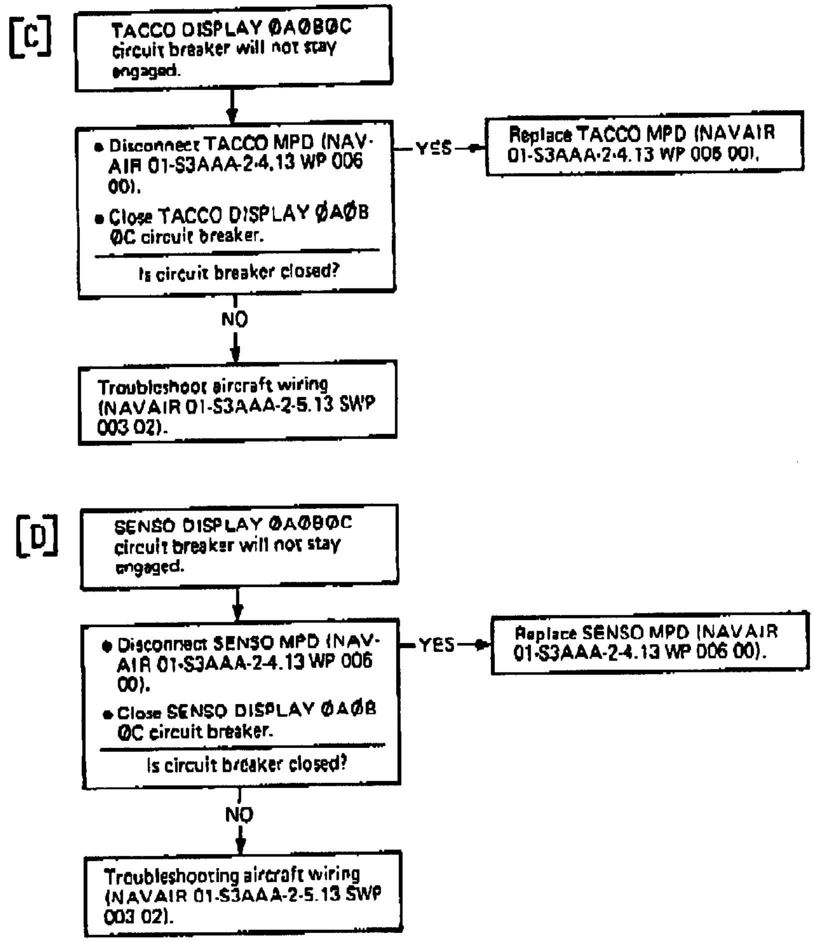


S3A2-3.13(3)0502(1)

Figure 4. Tactical-Acoustic Display Indicator Group Power Turn-on Troubleshooting Diagram (Applicable to aircraft not modified by ECP S3-378C2) (Sheet 1 of 5)

Figure A9.0-1 Example of Decision Tree



S3A2-3.13(2)0502(2)

Figure 4. Tactical-Acoustic Display Indicator Group Power Turn-on Troubleshooting Diagram (Applicable to aircraft not modified by ECP S3-378C2) (Sheet 2)

Figure A9.0-1 Example of Decision Tree (continued)

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005 00
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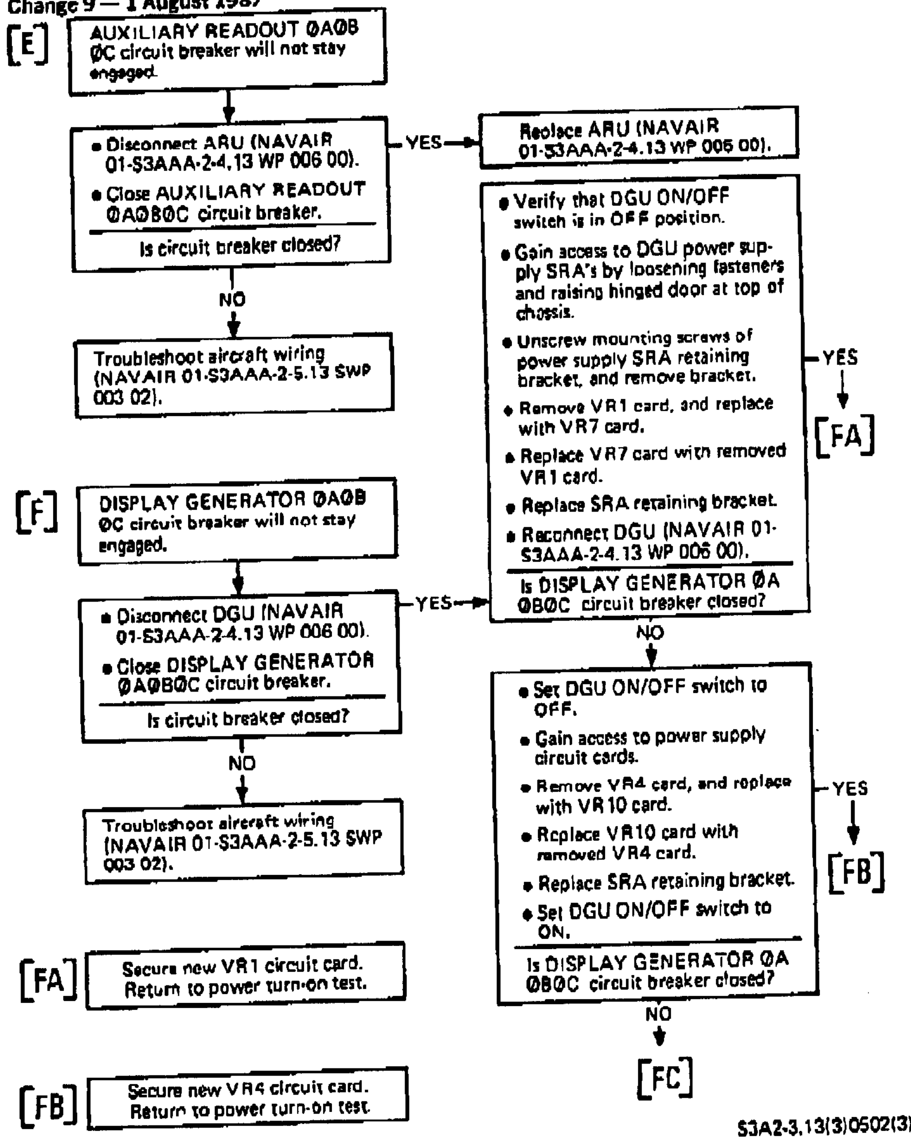

Figure 4. Tactical-Acoustic Display Indicator Group Power Turn-on Troubleshooting Diagram (Applicable to aircraft not modified by ECP S3-378C2) (Sheet 3)

Figure A9.0-1 Example of Decision Tree (continued)

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005 00
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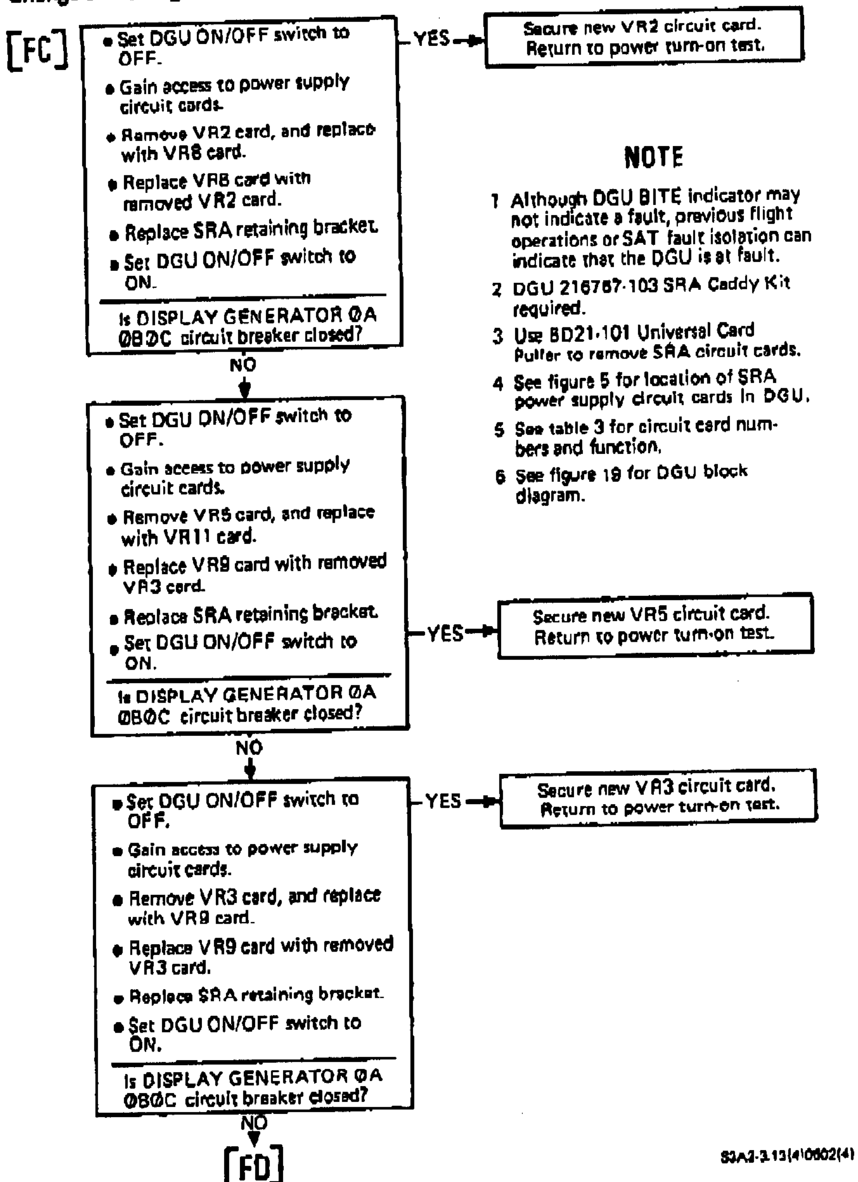
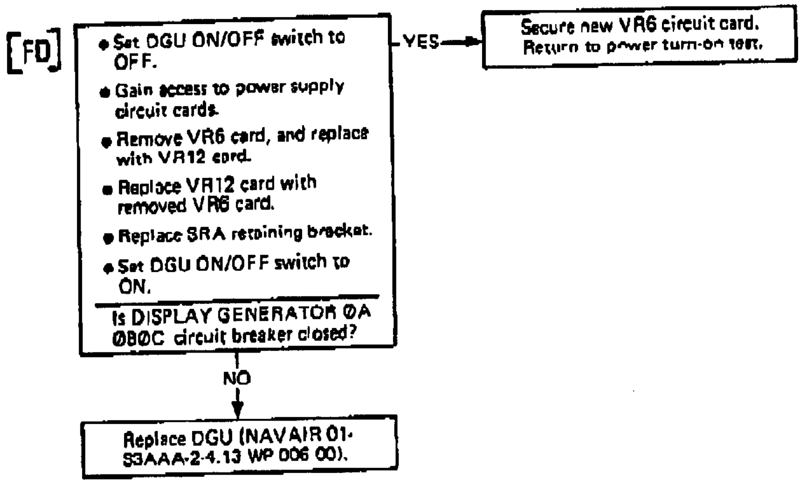


Figure 4. Tactical-Acoustic Display Indicator Group Power Turn-on Troubleshooting Diagram (Applicable to aircraft not modified by ECP S3-378C2) (Sheet 4)

Figure A9.0-1 Example of Decision Tree (continued)



NOTE

1 Although DGU BITE indicator may not indicate a fault, previous flight operations or SAT fault isolation can indicate that the DGU is at fault.
2 DGU 216767-103 SRA Caddy Kit required.
3 Use BD21-101 Universal Card Puller to remove SRA circuit cards.
4 See figure 5 for location of SRA power supply circuit cards in DGU.
5 See table 3 for circuit card numbers and function.
6 See figure 19 for DGU block diagram.

S3A2-3.13(4)0502(8)

Figure 4. Tactical-Acoustic Display Indicator Group Power Turn-on Troubleshooting Diagram (Applicable to aircraft not modified by ECP S3-378C2) (Sheet 5)

Figure A9.0-1 Example of Decision Tree (continued)

A10.0 DECISION TREE WITH CORRESPONDING TABLE

The following is an example of a graphical decision tree with corresponding table as found in troubleshooting information. This type of page accounted for 164 out of 13,518 pages surveyed.

A1-F18AC-270-200

005 00
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Table 5. No Windmill/Spooldown Airstart

Description:

A spooldown airstart is attempted while the engine is decelerating from a flameout or intentional shutdown. If the start attempt is not successful, the engine will decelerate to windmill speed and a windmill start can be attempted. Depending on where in the flight envelope the airstart at windmill is attempted, a crossbleed start may be required.

Key Questions to Ask Prior to Troubleshooting:

1. Did start attempt occur while aircraft was operating outside the flight envelope?

2. Was a crossbleed start attempted? Was it successful?

Support Equipment Required

None

Materials Required

None

NOTE

For component locator, refer to WP004 00.

Figure A10.0-1 Example of Decision Tree With Corresponding Table

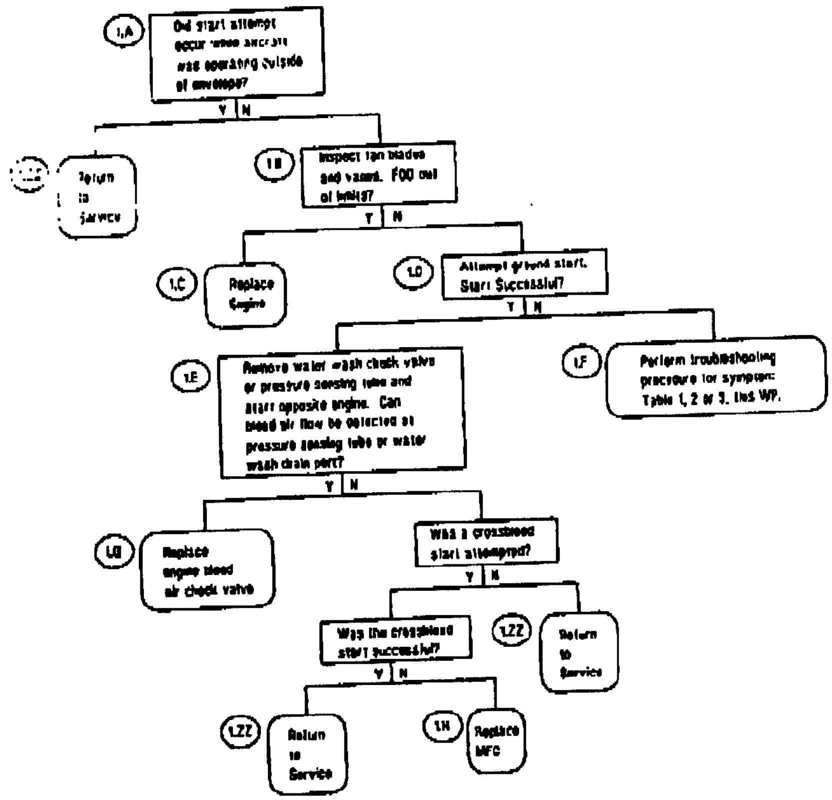

Table 5. No Windmill/Spooldown Airstart (Continued)

Figure A10.0-1 Example of Decision Tree With Corresponding Table (continued)

Table 5. No Windmill/Spooldown Airstart (Continued)

Step	Details of Check
1.A	Refer to NATOPS (A1-F18AC-NFM-000, Section V, Part 3).
1.B	CAUTION Move through engine inlet duct carefully to prevent damage to vortex generators on lower surface midway down the duct. 1. Enter engine inlet duct. 2. Inspect fan blades and vanes (A1-F18AC-270-300, WP063 00).
1.C	Replace engine (A1-F18AC-270-300, WP003 00) and do step 1.ZZ.
1.D	Start engine (A1-F18AC-LMM-000).
1.E	Do substeps below: 1. Shut down engine under investigation (A1-F18AC-LMM-000). 2. Open door 68L or R. 3. On 161358 and up: Remove water wash check valve from engine bleed air duct or cover plate from engine bleed air duct (A1-F18AC-410-300, WP005 00). On 161353 thru 161357: Remove pressure sensing tube (A1-F18AC-410-300, WP005 00) 4. Start opposite engine (A1-F18AC-LMM-000).
1.F	Go to the correct table in this work package for the symptom: No Start: Table 1 Hot Start: Table 2 Stall During Start: Table 3
1.G	Replace engine bleed air check valve (A1-F18AC-410-300, WP006 00) and do step 1.ZZ.
1.H	Replace main fuel control (MFC) (A1-F18AC-270-300, WP008 00) and do step 1.ZZ.

Figure A10.0-1 Example of Decision Tree With Corresponding Table (continued)

Table 5. No Windmill/Spooldown Airstart (Continued)

Step	Details of Check
1.ZZ	If opened, disconnected or removed during this procedure, make sure that the following items are closed, connected or installed: 1. Door 68L or R 2. Engine bleed air check valve 3. MFC 4. Pressure sensing tube 5. Water wash check valve or cover plate

Figure A10.0-1 Example of Decision Tree With Corresponding Table (continued)

A11.0 MAINTENANCE CODES/FAILURE CODES

The following is an example of a maintenance codes/failure codes table as found in troubleshooting information. This type of table accounted for 553 out of 13, 518 pages surveyed.

A1-F18AH-740-230 **204 00**
Page 2

Table 1. Station 2 Left Word 1 Data Readout Interpretation

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
NOTE When data readout is other than listed in the Data Readout column, multiple fails exist. Troubleshoot all signal lines for the Test/Signal descriptions which add up to the existing data readout. There are eleven octal digit locations in the DDI DATA readout. The six octal digits to the right are the data readout and each location reads 0 to 7. The five leading zeroes to the left remain zero and are ignored. When an X is indicated in one or more of the six right most octal digit locations in this procedure, that digit is ignored. EXAMPLE: Data readout is 00000XX6XXX; check signal lines for data readout XX4XXX and XX1XXX. Launcher Connector/Pin Column lists the launcher disconnect/pin for the failed signal line(s). Troubleshoot signal lines using the work package listed in the Maintenance Action column. Table 1 lists the components that can cause these failures.				
X23XXX	AIM-9 Audio		61P-W213 pin 19 or 61J-W254 pin 42	Do table 1, WP212 00.
X4XXXX	No Store Present	AIM-9 Ident	61P-W213 pin 26 or 61J-W254 pin 38	Do table 2, WP212 00.
X2XXXX	Twenty Five Volts	115vac 0C	61P-W213 pin 9 or 61J-W254 pin 52	Do table 1, WP213 00.
		Ground	61P-W213 pin 16 or 61J-W254 pin 53	
		Coolant Control	61P-W213 pin 20 or 61J-W254 pin 10	
		AIM-9 Audio	61P-W213 pin 19 or 61J-W254 pin 42	
		Launch Command	61P-W213 pin 1 or 61J-W254 pin 4	
		Master Arm (LAU-7)	61P-W213 pin 6	
		LAU-127 Unlock Command 2	61J-W254 pin 26	
		LAU-127 Unlock Command 1	61J-W254 pin 18	

Figure A11.0-1 Example of Maintenance Codes/Failure Codes

Table 1. Station 2 Left Word 1 Data Readout Interpretation (Continued)

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
X1XXXX	End To End Tester Present	AIM-9 Ident	61P-W213 pin 26 or 61J-W254 pin 38	Do table 2, WP213 00.
XX4XXX	Stray Voltage	115vac 6C	61P-W213 pin 9 or 61J-W254 pin 52	Do table 1, WP214 00.
		Ground	61P-W213 pin 16 or 61J-W254 pin 53	
XX2XXX	Fire Test	Launch Command	61P-W213 pin 1 or 61J-W254 pin 4	Do table 2, WP214 00.
		Master Arm (LAU-7)	61P-W213 pin 6	
		LAU-127 Unlock Command 2	61J-W254 pin 26	
		LAU-127 Unlock Command 1	61J-W254 pin 18	
XX1XXX	Stray Voltage BIT	Launch Command	61P-W213 pin 1 or 61J-W254 pin 4	Do table 1, WP215 00.
		Master Arm (LAU-7)	61P-W213 pin 6	
		LAU-127 Unlock Command 2	61J-W254 pin 26	
		LAU-127 Unlock Command 1	61J-W254 pin 18	
XXX4XX	Fire OFF	Launch Command	61P-W213 pin 1 or 61J-W254 pin 4	Do table 2, WP214 00.
		Master Arm (LAU-7)	61P-W213 pin 6	
		LAU-127 Unlock Command 2	61J-W254 pin 26	
		LAU-127 Unlock Command 1	61J-W254 pin 18	

Figure A11.0-1 Example of Maintenance Codes/Failure Codes (continued)

Table 1. Station 2 Left Word 1 Data Readout Interpretation (Continued)

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
XXX2XX	Head Command	Head Command	61P-W213 pin 22 or 61J-W254 pin 15	Do table 2, WP215 00.
		Manual Uncage	61P-W213 pin 25 or 61J-W254 pin 8	
XXX1XX	Uncage	Acquisition Lambda	61P-W213 pin 21 or 61J-W254 pin 16	Do table 1, WP216 00.
XXXX1X	Right/Left Reference	Right/Left Reference	61P-W213 pin 23 or 61J-W254 pin 44	Do table 1, WP216 00.
XXXX4X	Stray Voltage	115vac ØC	61P-W213 pin 9 or 61J-W254 pin 52	Do table 1, WP214 00.
		Ground	61P-W213 pin 16 or 61J-W254 pin 53	
XXXX2X	Power OFF	L 28vdc	61P-W213 pin 15 or 61J-W254 pin 30	Do table 2, WP216 00.

Table 2. Station 2 Right Word 2 Data Readout Interpretation

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
NOTE When data readout is other than listed in the Data Readout column, multiple fails exist. Troubleshoot all signal lines for the Test/Signal descriptions which add up to the existing data readout. There are eleven octal digit locations in the DDI DATA readout. The six octal digits to the right are the data readout and each location reads 0 to 7. The five leading zeroes to the left remain zero and are ignored. When an X is indicated in one or more of the six right most octal digit locations in this procedure, that digit is ignored. EXAMPLE: Data readout is 00000XX5XXX; check signal lines for data readout XX4XXX and XX1XXX. Launcher Connector/Pin Column lists the launcher disconnect/pin for the failed signal line(s). Troubleshoot signal lines using the work package listed in the Maintenance Action column. Table 1 lists the components that can cause these failures.				
X23XXX	AIM-9 Audio		61P-W212 pin 19 or 61J-W253 pin 42	Do table 1, WP217 00.

Figure A11.0-1 Example of Maintenance Codes/Failure Codes (continued)

Table 2. Station 2 Right Word 2 Data Readout Interpretation (Continued)

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
X4XXXX	No Store Present	AIM-9 Ident	61P-W212 pin 26 or 61J-W253 pin 38	Do table 1, WP218 00.
X2XXXX	Twenty Five Volts	115vac ØC	61P-W212 pin 9 or 61J-W253 pin 52	Do table 2, WP218 00.
		Ground	61P-W212 pin 16 or 61J-W253 pin 53	
		Coolant Control	61P-W212 pin 20 or 61J-W253 pin 10	
		AIM-9 Audio	61P-W212 pin 19 or 61J-W253 pin 42	
		Launch Command	61P-W212 pin 1 or 61J-W253 pin 4	
		Master Arm (LAU-7)	61P-W212 pin 6	
		LAU-127 Unlock Command 2	61J-W253 pin 26	
		LAU-127 Unlock Command 1	61J-W253 pin 18	
X1XXXX	End To End Tester Present	AIM-9 Ident	61P-W212 pin 26 or 61J-W253 pin 38	Do table 1, WP219 00.
XX4XXX	Stray Voltage	115vac ØC	61P-W212 pin 9 or 61J-W253 pin 52	Do table 2, WP219 00.
		Ground	61P-W212 pin 16 or 61J-W253 pin 53	
XX2XXX	Fire Test	Launch Command	61P-W212 pin 1 or 61J-W253 pin 4	Do table 1, WP220 00.
		Master Arm (LAU-7)	61P-W212 pin 6	
		LAU-127 Unlock Command 2	61J-W253 pin 26	
		LAU-127 Unlock Command 1	61J-W253 pin 18	

Figure A11.0-1 Example of Maintenance Codes/Failure Codes (continued)

Table 2. Station 2 Right Word 2 Data Readout Interpretation (Continued)

Data Readout	Test	Signal Line	Launcher Connector/Pin	Maintenance Action
XX1XXX	Stray Voltage BIT	Launch Command	61P-W212 pin 1 or 61J-W253 pin 4	Do table 2, WP220 00.
		Master Arm (LAU-7)	61P-W212 pin 6	
		LAU-127 Unlock Command 2	61J-W253 pin 26	
		LAU-127 Unlock Command 1	61J-W253 pin 18	
XXX4XX	Fire OFF	Launch Command	61P-W212 pin 1 or 61J-W253 pin 4	Do table 1, WP220 00.
		Master Arm (LAU-7)	61P-W212 pin 6	
		LAU-127 Unlock Command 2	61J-W253 pin 26	
		LAU-127 Unlock Command 1	61J-W253 pin 18	
XXX2XX	Head Command	Head Command	61P-W212 pin 22 or 61J-W253 pin 15	Do table 1, WP221 00.
		Manual Uncage	61P-W212 pin 25 or 61J-W253 pin 8	
XXX1XX	Uncage	Acquisition Lambda	61P-W212 pin 21 or 61J-W253 pin 16	Do table 2, WP221 00.
XXXX1X	Right/Left Reference	Right/Left Reference	61P-W212 pin 23 or 61J-W253 pin 44	Do table 2, WP221 00.
XXXX4X	Stray Voltage	115vac 8C	61P-W212 pin 9 or 61J-W253 pin 52	Do table 2, WP219 00.
		Ground	61P-W212 pin 16 or 61J-W253 pin 53	
XXXX2X	Power OFF	L 28vdc	61P-W212 pin 15 or 61J-W253 pin 30	Do table 1, WP222 00.

Figure A11.0-1 Example of Maintenance Codes/Failure Codes (continued)

A12.0 TEXT IN PARAGRAPH FORM

The following is an example of a page of text in paragraph form as found in troubleshooting information. This type of page accounted for 143 out of 13, 518 pages surveyed.

NAVAIR 01-S3AAA-2-3.13 **003 00**
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Alphabetical Index

Subject	Page No.
Testing and Troubleshooting	2
Off-line	2
On-line	2

Record of Applicable Technical Directives
None

1. TESTING AND TROUBLESHOOTING.

2. Testing and troubleshooting the Signal Data Recorder-Reproducer RD-348/ASH (digital magnetic tape unit) (figure 1) consists of on-line performance of the system test program (STP), off-line fault isolation of wiring harness and connectors, and observance of the weapon replaceable assembly built-in test equipment (BITE) indicator.

3. ON-LINE. The Signal Data Recorder-Reproducer RD-348/ASH is tested on-line by the General Purpose Digital Computer AN/AYK-10( )(V) (GPDC) STP during preflight and maintenance analysis, and by in-flight performance monitoring (IFPM) during normal operations. The GPDC STP consists of a system avionics test (SAT) which reports go/no go status, and which isolates and reports malfunctions in specific components. When the SAT advises replacement of the digital magnetic tape unit (DMTU) replacement procedures are contained in NAVAIR 01-S3AAA-2-4.13 WP 003 00, replace the tape cartridge transport and rerun the SAT. If the SAT again advises replacement, replace the DMTU (replacement procedures are contained in NAVAIR 01-S3AAA-2-4.13 WP 003 00). Procedures to perform the GPDC STP are provided in NAVAIR 01-S3AAA-2-3.1 SWP 005 05.

4. IFPM is conducted during normal operation each time a serial word is transferred to the GPDC. Bit 36 of each GPDC 36-bit input word is reserved to report equipment status (NAVAIR 01-S3AAA-2-2.13 WP 003 00).

5. On-line fault detection is displayed on the Tactical-Acoustic Display Indicator Group AN/ASA-82, commonly termed tactical display set (TDS), in the form of cues and alerts. Amplifying remarks are provided on the TDS. Amplifying remarks are initiated as the operator responds to cues by exercising the Computer-Indicator Control Group OK-184( )/ASQ-147 keysets. Amplifying remarks provided during operation of the STP guide the technician to maintenance actions in NAVAIR 01-S3AAA-2-4.13 WP 003 00. Amplifying remarks during IFPM guide the operator in determining a degraded or exclusive mode of operation.

6. OFF-LINE. Off-line troubleshooting consists of wiring and connector fault isolation using common ground support equipment and standard techniques. Principles of operation (NAVAIR 01-S3AAA-2-2.13 WP 003 00) provides an aid to the maintenance technician. Wiring harness and connector repair instructions are provided in NAVAIR 01-S3AAA-2-5.2 WP 001 00. The Signal Data Recorder-Reproducer RD-348/ASH power distribution diagram is shown in figure 2.

Figure A12.0-1 Example of Text in Paragraph Form

A13.0 TEXT IN OUTLINE FORM

The following is an example of a page of text in outline form as found in troubleshooting information. This type of page accounted for 612 out of 13, 518 pages surveyed.

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005 00
Page 8

8. Lamp Test.

CAUTION

Ensure that cooling is provided before the TDS is energized. Inspect DGU air hose connections whenever it is suspected that the DGU/MPD thermal protection circuits have activated.

a. Verify that EXT PWR switch on ELECTRIC PWR panel on center console is set to ON.

b. If Pilot's display edge-lighted panel is not on, replace lamp(s).

c. Replace lamps as follows:

(1) Turn MODE control switch on Pilot's display to OFF.

(2) Loosen mounting screws on control knobs and remove knobs.

(3) Loosen mounting screws and remove control panel assembly.

(4) Unscrew failed lamp holder on back side of control panel assembly and replace failed lamp.

d. Reinstall control panel assembly, and reinstall control knobs.

e. Verify that Pilot's display edge-lighted panel is on.

f. If Copilot's display edge-lighted panel is not on, replace failed lamp(s) in accordance with steps c, d, and e.

g. If TACCO or SENSO multipurpose display (MPD) edge-lighted panel is not on, replace failed lamp(s). Replace lamp(s) as follows:

(1) Turn MODE control switch on TACCO or SENSO MPD to OFF.

(2) Loosen mounting screws on control knobs and remove knobs.

(3) Loosen mounting screws and remove control panel assembly.

(4) Unscrew failed lamp holder on back side of control panel assembly and replace failed lamp.

h. Reinstall control panel assembly and reinstall control knobs.

i. Verify that TACCO or SENSO MPD edge-lighted panel is on.

j. If auxiliary readout unit (ARU) edge-lighted panel is not on, replace failed lamp(s). Replace lamp(s) as follows:

(1) Turn MODE control on ARU to OFF.

(2) Loosen mounting screws on control knobs and remove knobs.

(3) Loosen mounting screws and remove control panel assembly.

(4) Unscrew failed lamp holder on back side of control panel assembly and replace failed lamp.

k. Reinstall control panel assembly and reinstall control knobs.

l. Verify that ARU edge-lighted panel is on.

9. Tactical Indicator IP-1051/ASA-82 Functional Checkout. (Figure 8.)

a. Set MODE switch on Pilot's display to TEST, and set TEST switch to CRT-GRAPH. Turn BRT and FOCUS controls for best display. Check that display is the same as test pattern 1 (figure 7).

Figure 8(A)

For aircraft modified by ECP S3-378C2 Figure 8A (A).

b. Set TEST switch on Pilot's display to DGU-CONIC, -CHAR, or -VEC. Check that display is the same as test pattern 2 (figure 7).

Figure 8(B)

For aircraft modified by ECP S3-378C2 Figure 8A (B).

Figure A13.0-1 Example of Text in Outline Form

A14.0 GRAPHIC

The following is an example of a graphic figure as found in troubleshooting information. This type of page accounted for 1,382 out of 13, 518 pages surveyed.

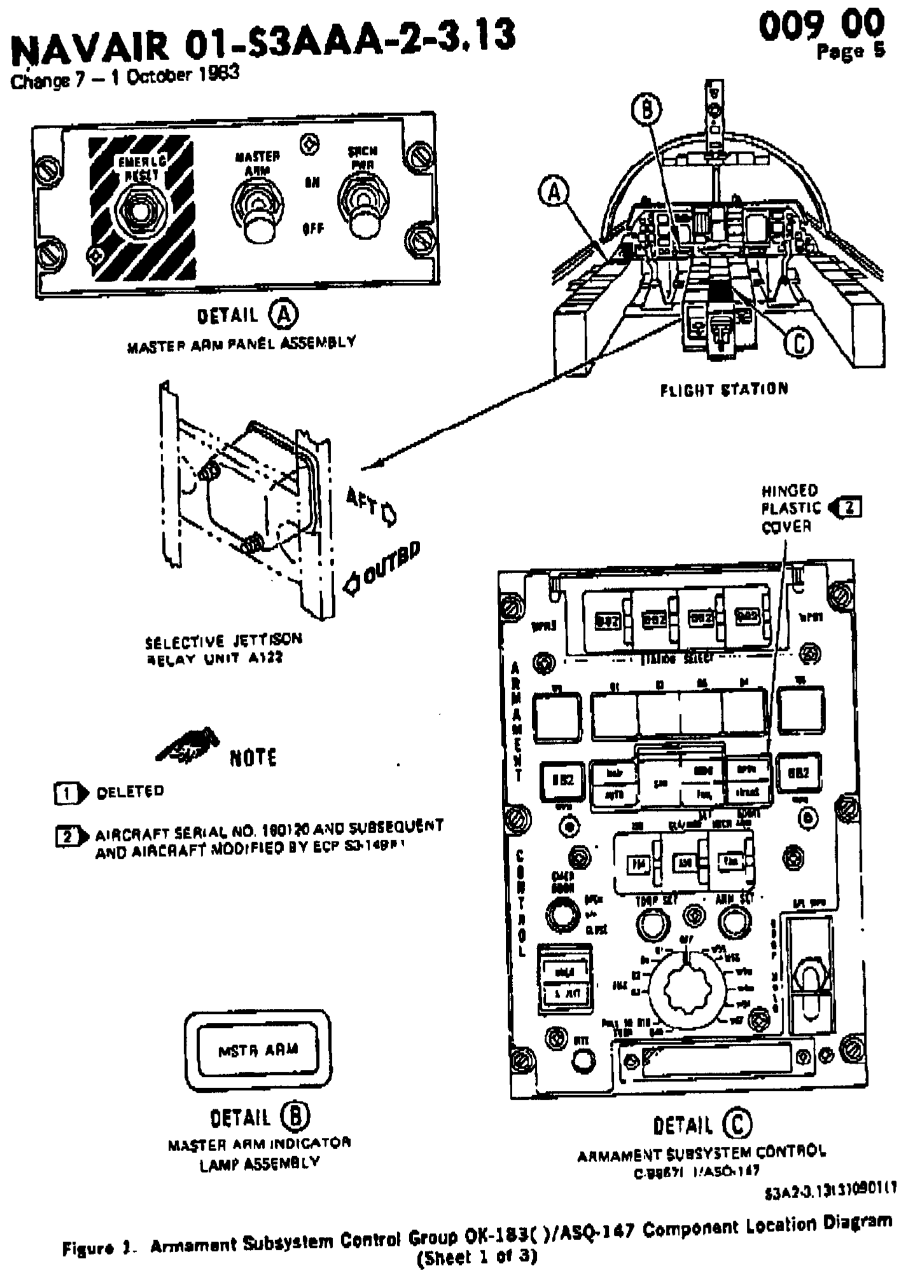

Figure A14.0-1 Example of Graphic

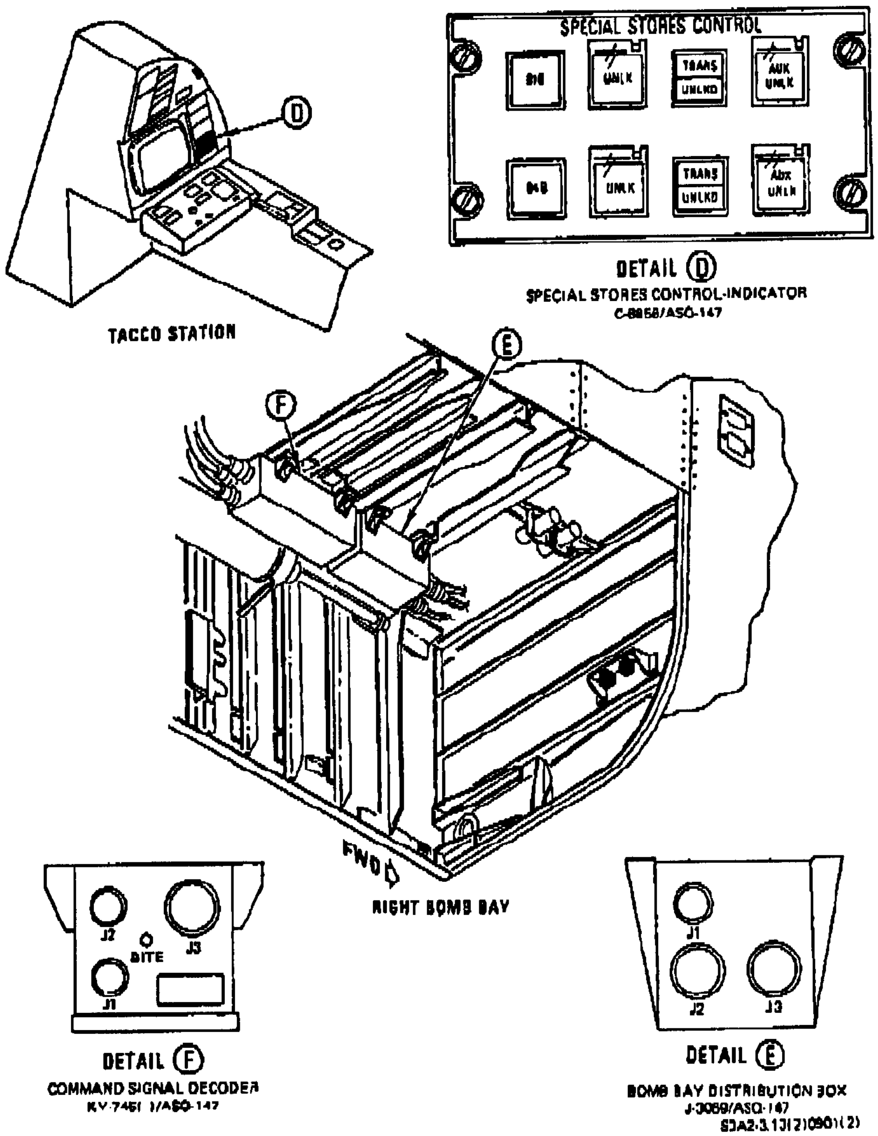

Figure 1. Armament Subsystem Control Group OK-183( )/ASQ-147 Component Location Diagram (Sheet 2)

Figure A14.0-1 Example of Graphic (continued)

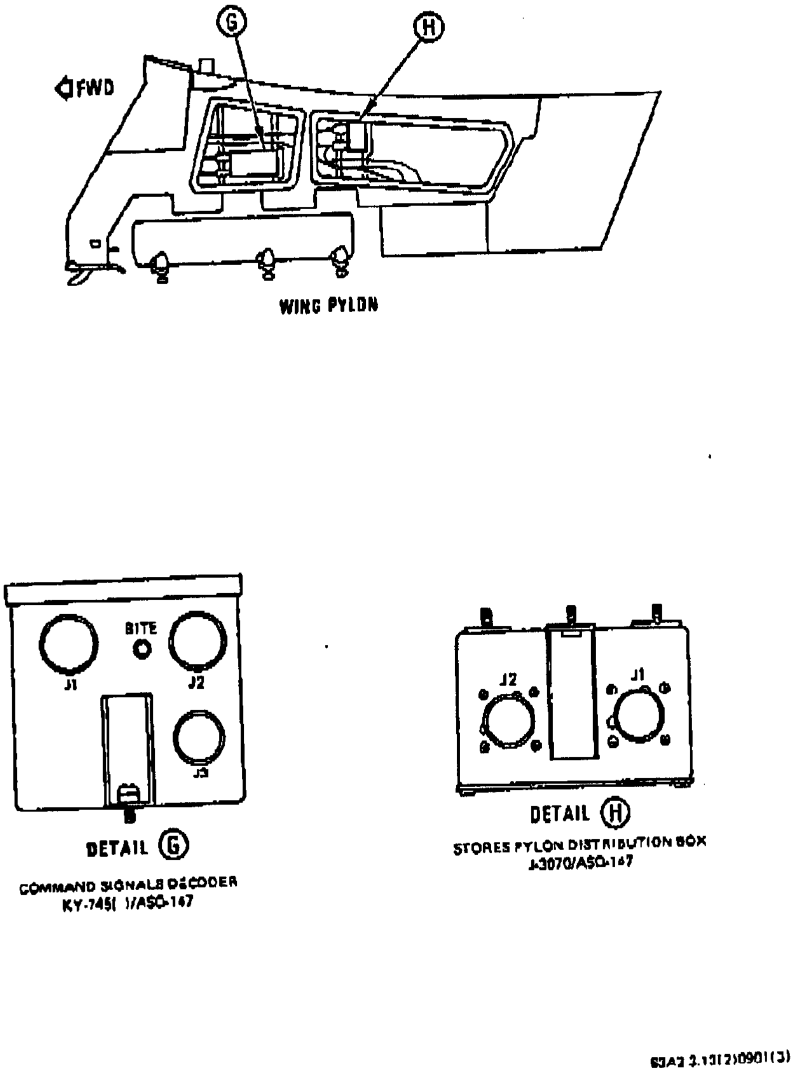

Figure 1. Armament Subsystem Control Group OK-183( )/ASQ-147 Component Location Diagram (Sheet 3)

Figure A14.0-1 Example of Graphic (continued)

A15.0 GENERAL TABLE

The following is an example of a general table as found in troubleshooting information. This type of table accounted for 630 out of 13, 518 pages surveyed.

A1-F18AE-760-200 **034 00**
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Table 8. High Band Test Hookup For Insertion Loss

Hook up No.	Frequency Range	USM-482 Detector to Antenna Circuit (Input)		USM-482 RF Cable/Adapters to Antenna Circuit (Output)		Maximum Insertion Loss (in dB)	
		Ref Des	Type Connector	Ref Des	Type Connector	F/A-18C	F/A-18D
1	F4	Forward Waveguide Segment 9	WRD750	Forward Waveguide Segment 9	WRD750	0.45	0.45
2	F4	Forward Waveguide Segment 9A	WRD750	Forward Waveguide Segment 9A	WRD750	0.35	0.35
3	F4	64P-E001S	TNC male	64P-F031B	TNC male	2.1	2.8
4	F4	64P-F031A	TNC male	64P-E001R	TNC male	2.4	2.9
5	F4	Forward Waveguide Segment 8A	WRD750	Forward Waveguide Segment 8A	WRD750	0.10	0.10
6	F4	Adapter	TNC male	Forward High Band Hybrid	WRD750	4.40	4.40

LEGEND

Sweep frequencies are listed in Countermeasures Set Swept Frequencies, table 1 (A1-F18AE-760-210/(S), WP003 00).

Table 9. Antenna Return Loss Test Hookup

Hookup No.	USM 482 Bridge to Antenna		Frequency Range	Minimum Return Loss (in dB)
	Antenna	Type Connector		
1	64E-A540 - Forward Upper Left High Band Transmit Antenna	TNC female	F5	10.2
2	64E-B541 - Forward Upper Right High Band Transmit Antenna	TNC female	F5	10.2
3	64E-S014 - Aft High Band Transmit Antenna	TNC female	F5	10.2
4	64E-B017 - Forward Lower High Band Transmit Antenna	TNC female	F5	10.2

Figure A15.0-1 Example of General Table

Table 9. Antenna Return Loss Test Hookup (Continued)

Hookup No.	USM 482 Bridge to Antenna		Frequency Range 1	Minimum Return Loss (in dB)
	Antenna	Type Connector		

LEGEND

1 Sweep frequencies are listed in Countermeasures Set Swept Frequencies, table 1 (A1-F18AE-760-210/(S), WP003 00).

Table 10. High Band Test Hookup For Fault Isolation

Hookup No.	Frequency Range 1	Distance To Fault Sweep (UDT)		Transmission Line Data	
		From Connector (type)	To Connector (type)	Length (in Feet)	Vp
1	F4	64W-B573 Adapter (WRD750)	64P-E00R (TNC male)	31.58 2 33.75 3	76%
2	F4	Aft Waveguide Segment 1 (WRD750)	Aft Waveguide Segment 11 (WRD750)	39.33 2 38.90 3 39.32 4 38.90 5	76%
3	F4	64W-B575 Adaptor (WRD750)	64P-E001R (TNC male)	20.19	76%

LEGEND

1 Sweep frequencies are listed in Countermeasures Set Swept Frequencies, table 1 (A1-F18AE-760-210/(S), WP003 00).
2 F/A-18C 163427 THRU 164278.
3 F/A-18C 164627 AND UP.
4 F/A-18D 163434 THRU 164279.
5 F/A-18D 164649 AND UP.

Table 11. Antenna Circuit Coax Cables

WRA or Cable no.	Connector 1		Connector 2		Length (in ft)	Vp	IL (dB)	Freq Range 1
	Ref Des	Type	Ref Des	Type				
TE234A 2	64P-E001R	TNC male	64P-F031A	TNC male	6.64	76%	2.4	F4
TE234A 3	64P-E001R	TNC male	64P-F031A	TNC male	8.71	76%	2.9	F4
TE235A 2	64P-E001S	TNC male	64P-F031A	TNC male	6.17	76%	2.1	F4
TE235A 3	64P-E001S	TNC male	64P-F031A	TNC male	8.63	76%	2.8	F4

Figure A15.0-1 Example of General Table (continued)

Table 11. Antenna Circuit Coax Cables (Continued)

WRA or Cable no.	Connector 1		Connector 2		Length (in ft)	Vp	IL (dB)	Freq Range 1
	Ref Des	Type	Ref Des	Type				
TE300A	64P-B082	TNC male	64P-B074A	TNC male	3.23	76%	1.5	F4
TE301A	64P-B074A	TNC male	64P-B081A	TNC male	1.13	76%	1.1	F4
TE302A	64P-B083	TNC male	64P-B017	TNC male	3.1	76%	1.5	F4

LEGEND

1 Sweep frequencies are listed in Countermeasures Set Swept Frequencies, table 1 (A1-F18AE-760-210/(S), WP003 00).
2 F/A-18C.
3 F/A-18D.

Table 12. Antenna Circuit Waveguide Segments

Segment Number	Freq Range 1	Cut Off Freq (MHz)	Insertion Loss (dB)	Length (in ft)	Flange Type	Replacement WP (A1-F18AE-760-300) Access/Door
Forward Waveguide Segments						
1	F5	750	0.35	1.61	WRD-750	WP078 00/Door 13R
2	F5	750	0.25	1.11	WRD-750	WP078 00/Door 13R
3	F5	750	0.57	2.54	WRD-750	WP079 00/Door 10R
4	F5	750	0.45	2.89	WRD-750	WP079 00/Door 10R
5	F5	750	0.40	2.6	WRD-750	WP080 00/Door 10R
6	F5	750	0.38	2.21	WRD-750	WP080 00/Nose barrel
7	F5	750	0.25	2.69	WRD-750	WP080 00/Nose barrel
8	F5	750	0.32	1.72	WRD-750	WP081 00/Nose barrel
8A	F5	750	0.10	0.27	WRD-750	WP081 00/Nose barrel
9	F5	750	0.45	2.46	WRD-750	WP082 00/Nose barrel
9A	F5	750	0.35	0.78	WRD-750	WP082 00/Nose barrel
Aft Waveguide Segments						
1 2	F5	750	0.29	0.61	WRD-750	WP070 00/Door 13R
1 3	F5	750	0.25	3.27	WRD-750	WP072 00/

Figure A15.0-1 Example of General Table (continued)

Table 12. Antenna Circuit Waveguide Segments (Continued)

Segment Number	Freq Range $\boxed{1}$	Cut Off Freq (MHz)	Insertion Loss (dB)	Length (In ft)	Flange Type	Replacement WP (A1-F18AE-760-300) Access/Door
2 $\boxed{2}$	F5	750	0.31	2.98	WRD-750	071 00
2 $\boxed{3}$	F5	750	0.45	2.76	WRD-750	072 00
3 $\boxed{2}$	F5	750	0.33	1.62	WRD-750	071 00
3 $\boxed{3}$	F5	750	0.45	2.43	WRD-750	073 00
4 $\boxed{2}$	F5	750	0.55	1.41	WRD-750	074 00
4 $\boxed{3}$	F5	750	0.30	1.80	WRD-750	073 00
4A $\boxed{2}$	F5	750	0.9	3.82	WRD-750	074 00
5 $\boxed{2}$	F5	750	0.35	9.17	WRD-750	075 00
5 $\boxed{3}$	F5	750	0.35	9.33	WRD-750	075 00
6	F5	750	0.25	5.67	WRD-750	075 00
7 $\boxed{4}$	F5	750	0.45	2.75	WRD-750	076 00
7A $\boxed{5}$	F5	750	0.57	0.55	WRD-750	076 00
7B $\boxed{5}$	F5	750	0.2	1.71	WRD-750	076 00
8 $\boxed{4}$	F5	750	0.25	0.89	WRD-750	076 00
8 $\boxed{5}$	F5	750	0.75	0.05	WRD-750	076 00
9	F5	750	0.4	1.1	WRD-750	076 00
10	F5	750	0.82	7.45	WRD-750	077 00
11	F5	750	0.24	1.89	WRD-750	077 00

LEGEND

$\boxed{1}$ Sweep frequencies are listed in Countermeasures Set Swept Frequencies, table 1 (A1-F18AE-760-210/(S), WP003 00).
$\boxed{2}$ F/A-18C.
$\boxed{3}$ F/A-18D.
$\boxed{4}$ 163427 THRU 164279.
$\boxed{5}$ 164627 AND UP.

Figure A15.0-1 Example of General Table (continued)

A16.0 POWER DISTRIBUTION DIAGRAM

(Originally a single page fold-out)

The following is an example of a power distribution diagram as found in troubleshooting information. This type of diagram accounted for 13 out of 13, 518 pages surveyed.

NAVAIR 01-S3AAA-2-3.13 010 00

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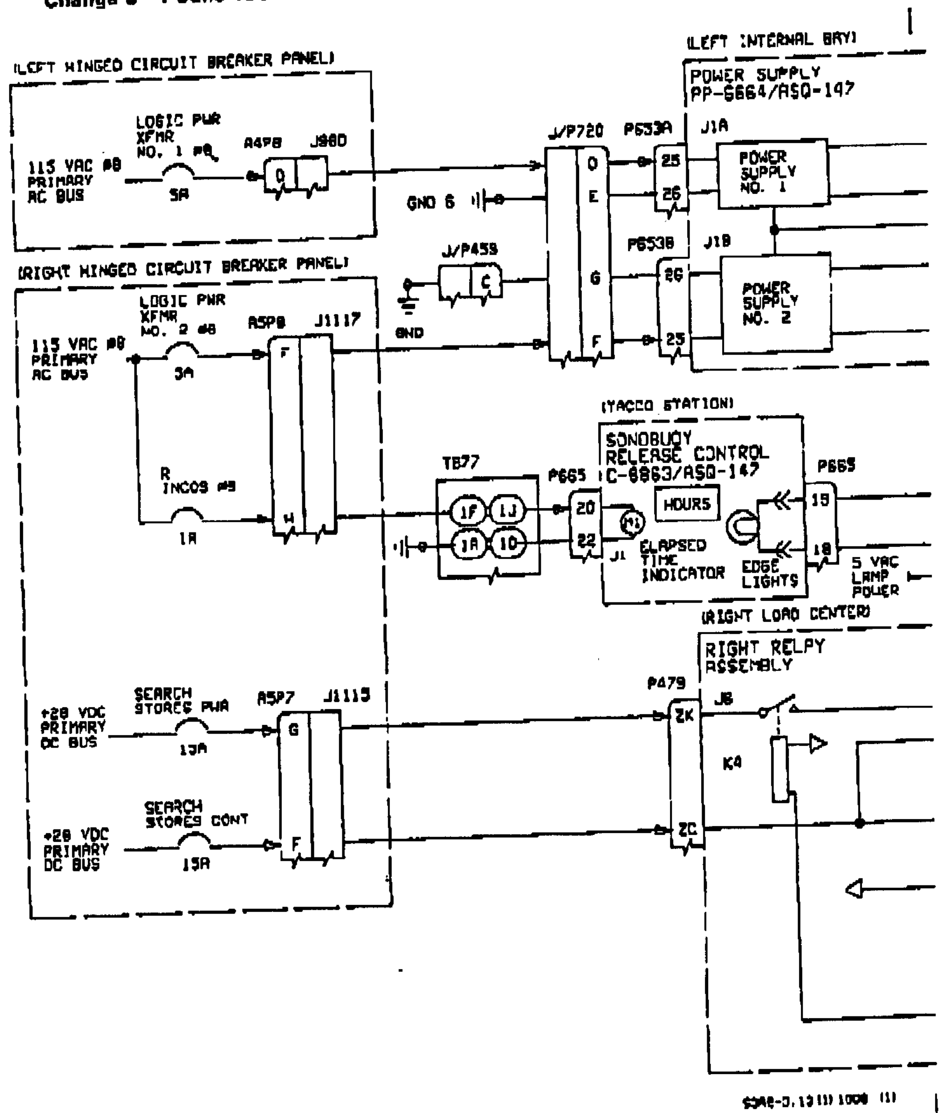

Figure 12. Search Stores Control Group OK-185( )/ASQ-147 Power Distribution Diagram (Sheet 1 of 4)

Figure A16.0-1 Example of Power Distribution Diagram

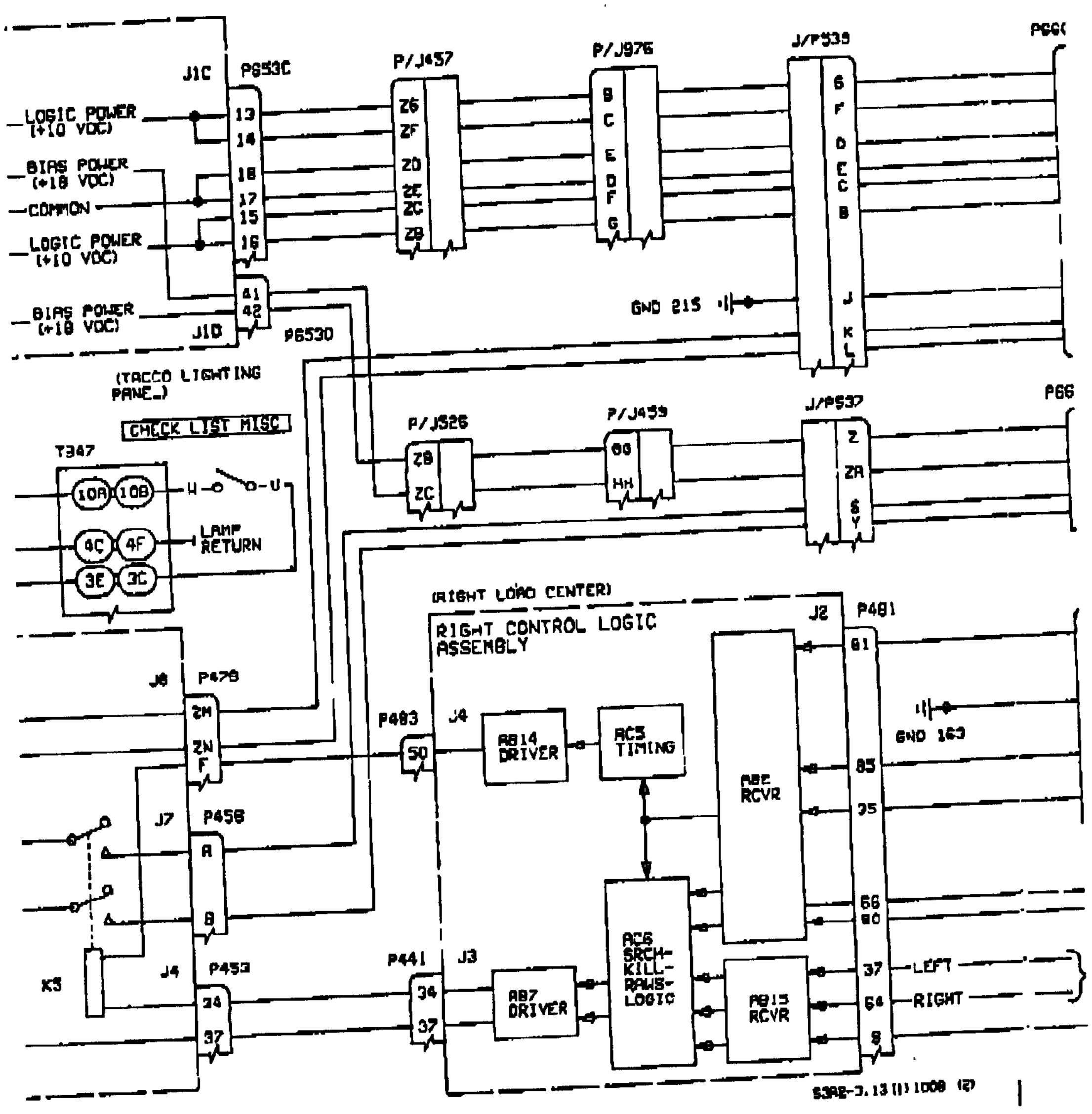

Figure 12. Search Stores Control Group OK-185( )/ASQ-147 Power Distribution Diagram (Sheet 2)

Figure A16.0-1 Example of Power Distribution Diagram (continued)

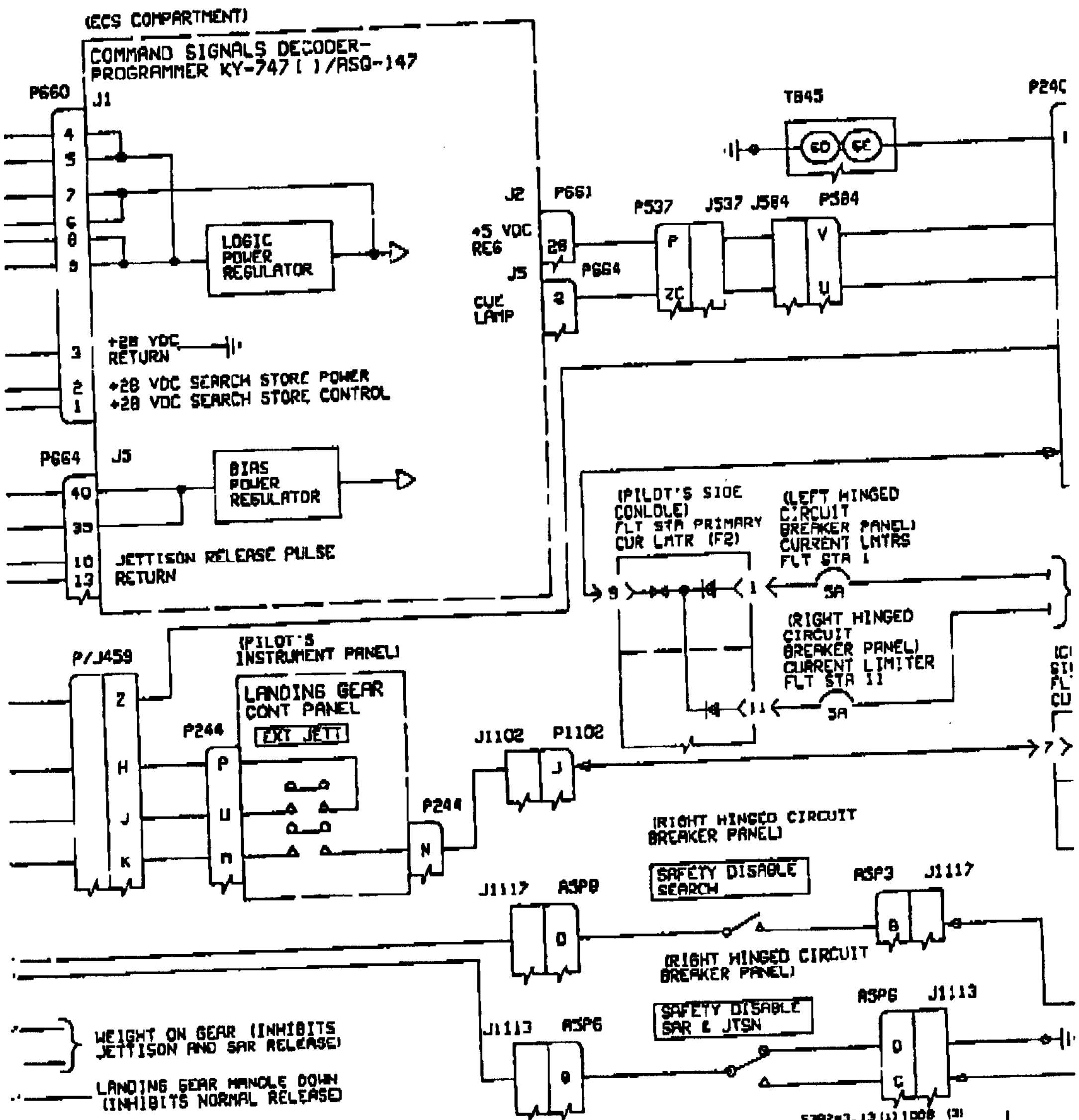

Figure 12. Search Stores Control Group OK-185( )/ASQ-147 Power Distribution Diagram (Sheet 3)

Figure A16.0-1 Example of Power Distribution Diagram (continued)

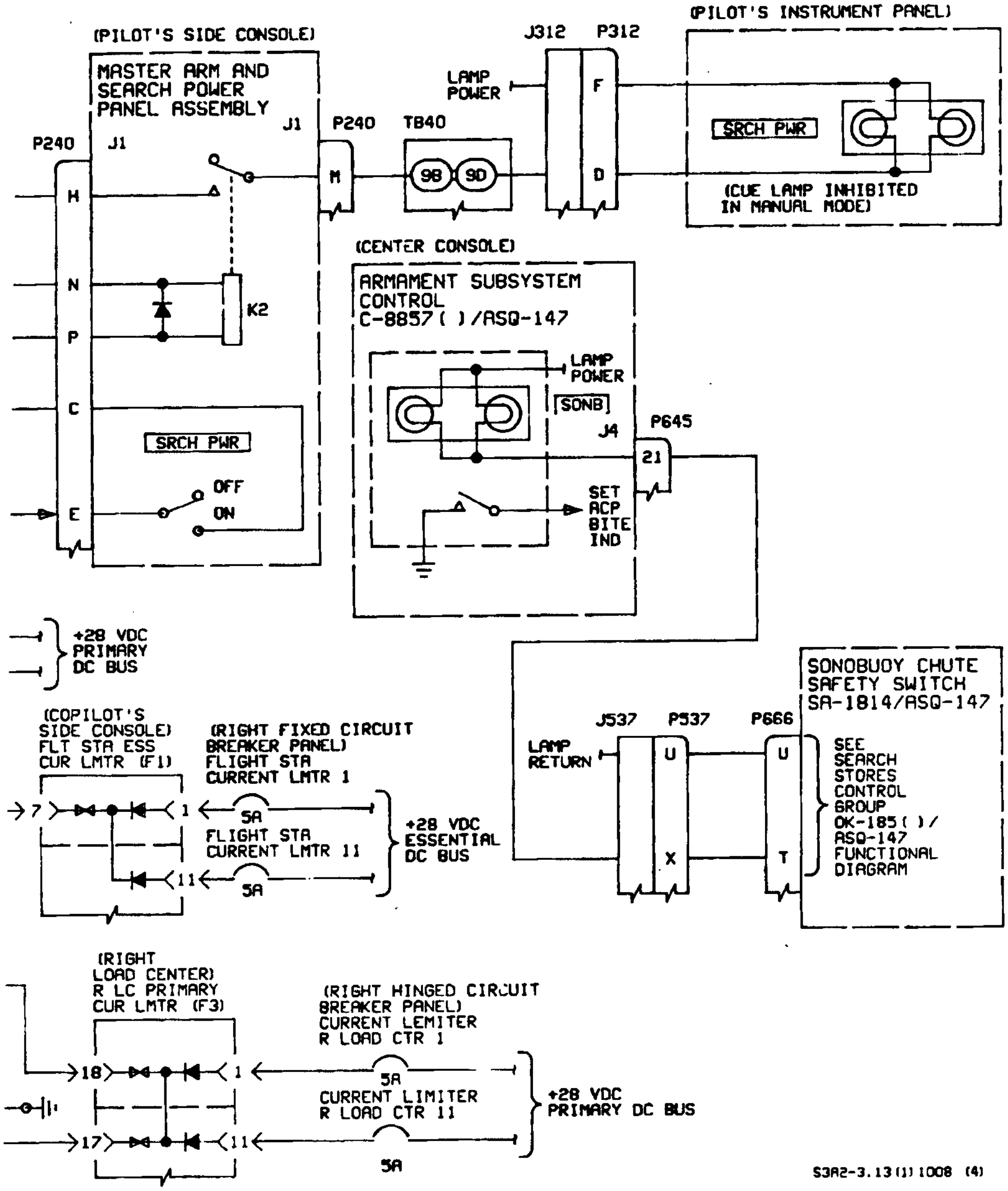

Figure 12. Search Stores Control Group OK-185( )/ASQ-147 Power Distribution Diagram (Sheet 4)

Figure A16.0-1 Example of Power Distribution Diagram (continued)

A17.0 FUNCTION BLOCK DIAGRAM

The following is an example of a function block diagram as found in troubleshooting information. This type of diagram accounted for 936 out of 13, 518 pages surveyed.

NAVAIR 01-S3AAA-2-3.13 **005 00**

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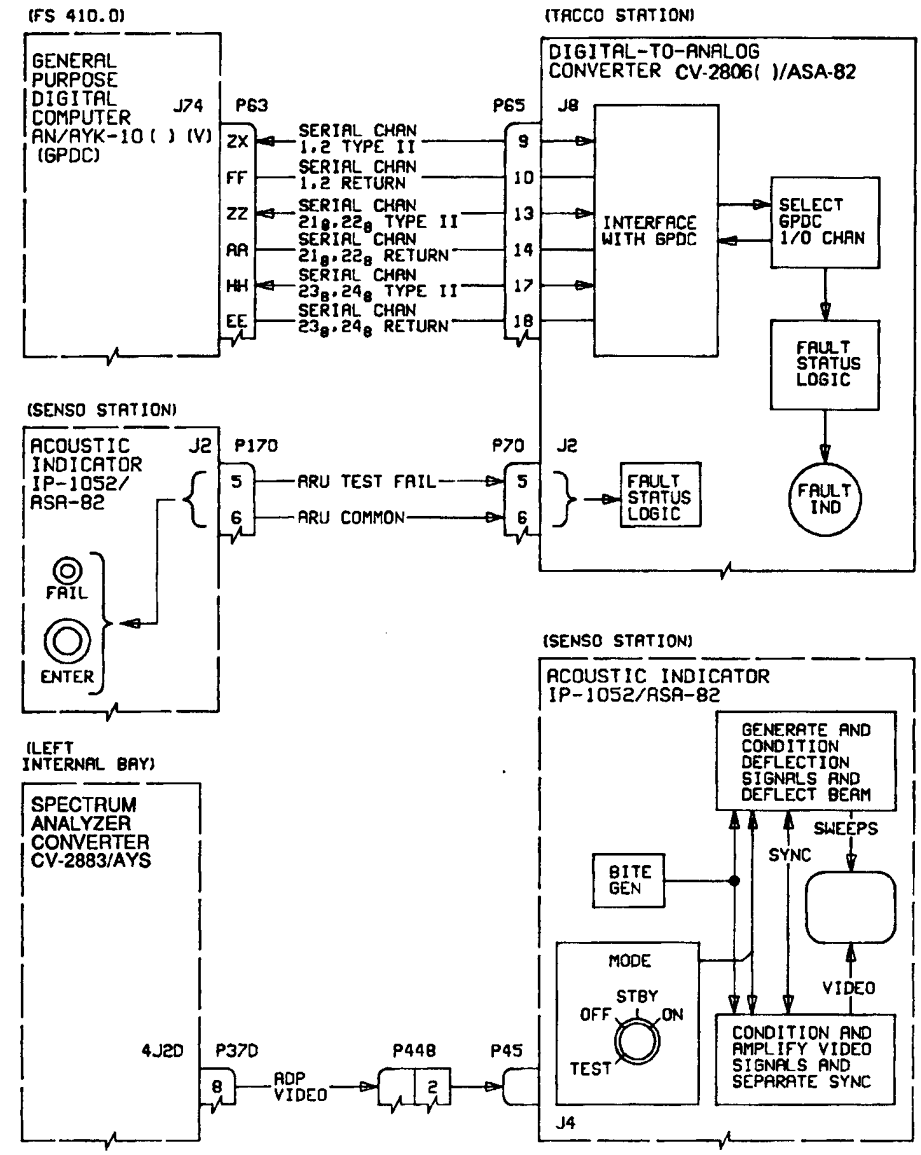

Figure 17. Acoustic Indicator (SENSO ARU) Functional Diagram (Applicable to aircraft not modified by ECP S3-378C2)

Figure A17.0-1 Example of Function Block Diagram

A18.0 FAULT ISOLATION DIAGRAM

The following is an example of a fault isolation diagram as found in troubleshooting information. This type of diagram accounted for 1 out of 13, 518 pages surveyed.

NAVAIR 01-S3AAA-2-3.13 **010 00**
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	LAUNCH SIGNAL								RETURN SIGNAL							
SLC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A1	X								X							
A2					X				X							
B1			X							X						
B2							X			X						
C1						X			X							
C2		X							X							
D1	X										X					
D2				X							X					
D3							X				X					
D4		X									X					
D5					X						X					
D6								X			X					
D7			X								X					
D8						X					X					
E1	X												X			
E2				X									X			
E3							X						X			
E4		X											X			
E5					X								X			
E6								X					X			
E7			X										X			
E8						X							X			
F1	X														X	
F2				X											X	
F3							X								X	
F4		X													X	
F5					X										X	
F6								X							X	
F7			X												X	
F8						X									X	

S3A2-3.13(1)1007 (1)

Figure 11. Quick-look Fault Isolation Diagram (Sheet 1 of 3)

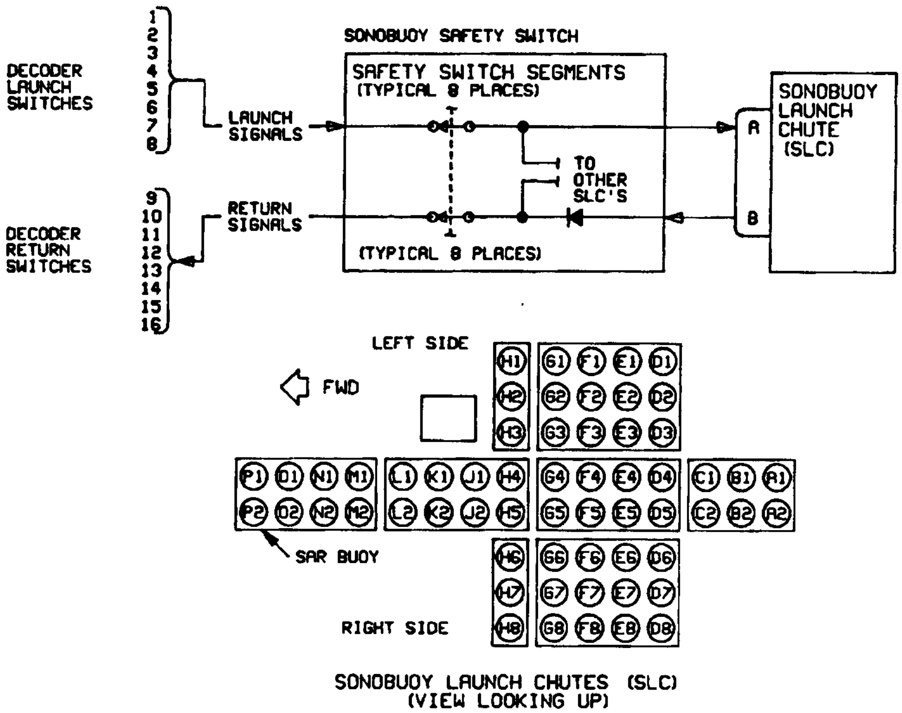
Figure A18.0-1 Example of Fault Isolation Diagram

SLC	LAUNCH SIGNAL 1	2	3	4	5	6	7	8	RETURN SIGNAL 9	10	11	12	13	14	15	16
G1	X											X				
G2				X								X				
G3							X					X				
G4		X										X				
G5					X							X				
G6								X				X				
G7			X									X				
G8						X						X				
H1	X													X		
H2				X										X		
H3							X							X		
H4		X												X		
H5					X									X		
H6								X						X		
H7			X											X		
H8						X								X		
J1			X						X							
J2							X		X							
K1	X									X						
K2					X					X						
L1						X				X						
L2		X								X						
M1	X															X
M2					X											X
N1								X	X							
N2				X					X							
O1								X		X						
O2				X						X						
P1								X								X
P2	(SEE SAR BUOY FUNCTIONAL DIAGRAM)															

S3A2-3.13 (1) 1007 (2)

Figure 11. Quick-look Fault Isolation Diagram (Sheet 2)

Figure A18.0-1 Example of Fault Isolation Diagram (continued)



- USE THE MATRIX AT LEFT TO ISOLATE FAULT TO AN SLC AND ITS ADJACENT WIRING, OR TO A SONOBUOY SAFETY SWITCH SEGMENT AND ITS ASSOCIATED LAUNCH SIGNAL OR RETURN SIGNAL WIRING.

- THE X'S IN THE MATRIX INDICATE THE LAUNCH AND RETURN SIGNALS (AND THEIR ASSOCIATED SONOBOUY SAFETY SWITCH SEGMENTS) WHICH AFFECT SPECIFIC SLC'S.

- FAULT ISOLATION EXAMPLES:

  1. A FAILURE OF SLC'S D2, E2, F2, G2, H2, N2, AND O2 INDICATES A FAILURE OF LAUNCH SIGNAL/SAFETY SWITCH SEGMENT 4.

  2. A FAILURE OF ALL THE SLC'S IN THE H ROW (H1 THROUGH H8) INDICATES A FAILURE IN RETURN SIGNAL/SAFETY SWITCH SEGMENT 14.

  3. FAILURES THAT DO NOT FALL INTO ANY OF THE PATTERNS OF X'S IN THE MATRIX INDICATE INDIVIDUAL SLC OR ADJACENT WIRING FAILURES.

S3A2-3.13 (1) 1007 (3)

Figure 11. Quick-look Fault Isolation Diagram (Sheet 3)

Figure A18.0-1 Example of Fault Isolation Diagram (continued)

A19.0 SCHEMATIC

(ORIGINALLY A SINGLE PAGE FOLD-OUT)

The following is an example of a schematic diagram as found in troubleshooting information. This type of diagram accounted for 326 out of 13, 518 pages surveyed.

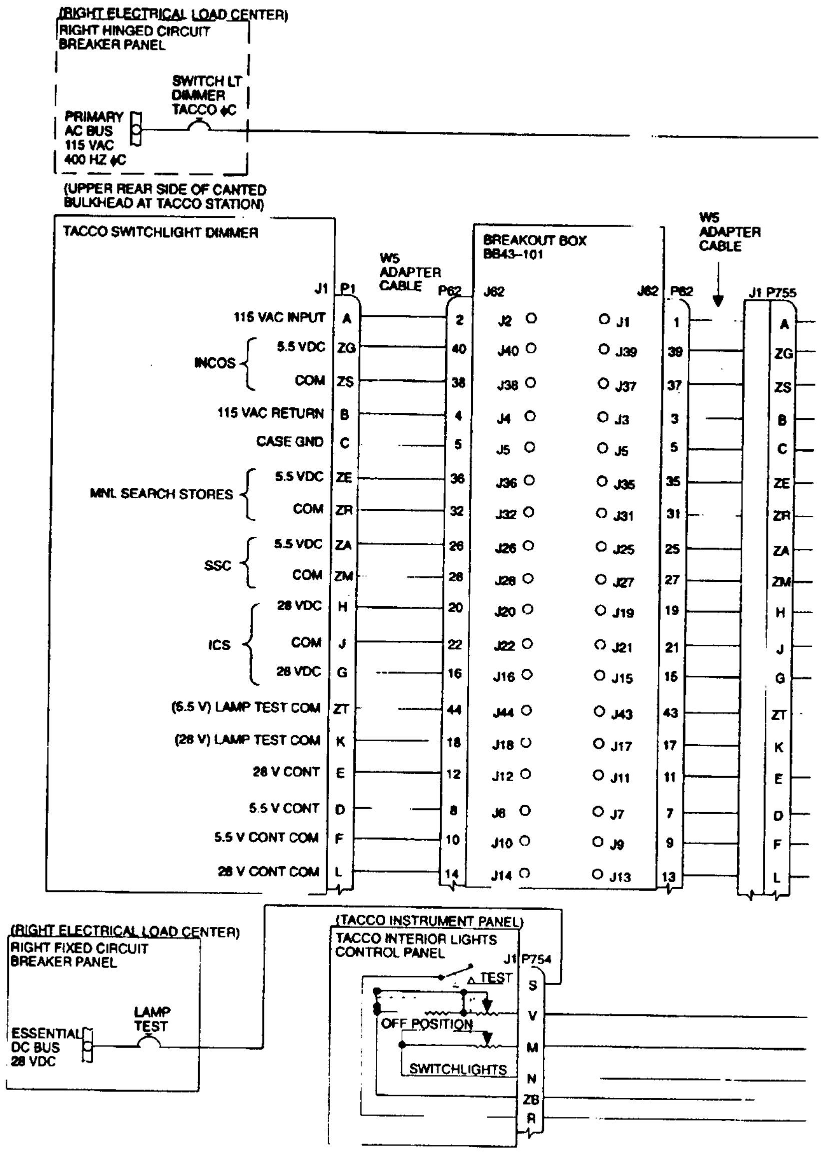


Figure A19.0-1 Example of Schematic

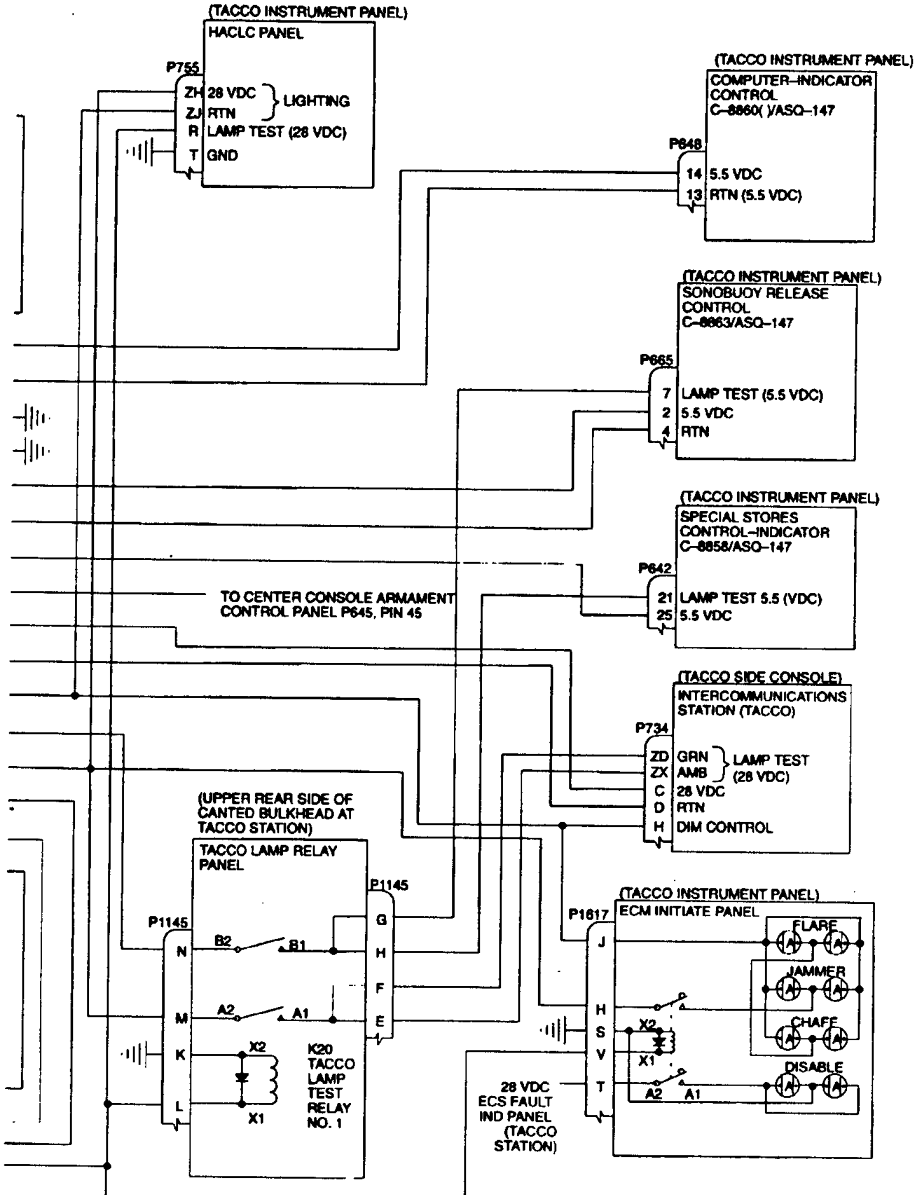


Figure 14 TACCO Switchlight Dimmer Troubleshooting Schematic

Figure A19.0-1 Example of Schematic (continued)

A20.0 NOMENCLATURE

The following is an example of a page of nomenclature as found in troubleshooting information. This type of page accounted for 342 out of 13, 518 pages surveyed.

A1-F18AE-760-200 **004 00**
Page 7

Nomenclature	Index No.	Ref Des
ALQ-165 EQUIPMENT RACK	14	64A-E028
COMMAND LAUNCH COMPUTER	19	61A-F010
2 COMPUTER POWER SUPPLY	9	60A-A505
CONTROL-CONVERTER	17	82A-F001
DIGITAL DATA COMPUTER NO. 1	16	83A-E001
ELECTRONIC EQUIPMENT CONTROL	4	79A-J006
GND PWR CONTROL PANEL ASSEMBLY	5	1A-H004
HEAD-UP DISPLAY	2	79A-J001
INTERFERENCE BLANKER	20	66A-F001
LEFT DIGITAL DISPLAY INDICATOR	1	80A-H001
NOSE WHEELWELL DIGITAL DISPLAY INDICATOR	8	83A-G003
NO. 2 CIRCUIT BREAKER PANEL ASSEMBLY	22	52A-D024
NO. 2 RELAY PANEL ASSEMBLY	21	52A-F058
NO. 4 CIRCUIT BREAKER PANEL ASSEMBLY	23	52A-D026
NO. 7 CIRCUIT BREAKER/RELAY PANEL ASSEMBLY	25	52A-C057
NO. 8 CIRCUIT BREAKER/RELAY PANEL ASSEMBLY	24	52A-C159
3 RADAR DATA PROCESSOR	11	60A-A503
RADAR RECEIVER-TRANSMITTER	12	72A-A002
2 RADAR TARGET DATA PROCESSOR	10	60A-A503
REAR ELECTRONIC EQUIPMENT CONTROL	6	76A-L028
ELECTRONIC ALTIMETER RECEIVER-TRANSMITTER	7	67A-T001
RECEIVER-TRANSMITTER (ALQ-126B)	13	64A-E001

Figure 1. Interference Blanker System Locator (Sheet 6)

Figure A20.0-1 Example of Nomenclature

A21.0 SETUP

The following is an example of a setup procedure as found in troubleshooting information. This type of page accounted for 596 out of 13, 518 pages surveyed.

A1-F18AE-760-200 **004 00**

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Nomenclature	Index No.	Ref Des
IFF RECEIVER-TRANSMITTER	15	78A-E001
TACAN RECEIVER-TRANSMITTER	18	69A-F001
RIGHT DIGITAL DISPLAY INDICATOR	3	80A-J002

LEGEND

1. AIRCRAFT CONNECTOR LOCATIONS ARE SHOWN IN A1-F18A( )-WDM-000.
2. 163427 THRU 164279; ALSO 164627 THRU 164897 BEFORE F/A-18 AFC 211.
3. 164898 AND UP; ALSO 164627 THRU 164897 AFTER F/A-18 AFC 211.

Figure 1. Interference Blanker System Locator (Sheet 7)

Figure A21.0-1 Example of Setup

- high band transmit/receive (WP027 00)

5. Countermeasures set (ALQ-165) antenna system testing, insertion loss and return loss, is divided as listed below:

- low/high band receive (WP028 00)

- low band transmit (WP029 00)

- high band transmit (WP027 00)

6. When doing countermeasures set antenna system return loss and insertion loss checks requested by scheduled maintenance, WP025 00, WP026 00 and WP027 00 or WP028 00 and WP029 00 and must be accomplished. When doing insertion loss, return loss checks as a result of unscheduled maintenance, do only the applicable work package.

7. Unique countermeasures warning and control system return loss and insertion loss checks are in WP051 00.

Table 1. Initial Setup

Support Equipment Required

Part Number or Type Designation	Nomenclature
AN/USM-402A(V)1	Swept Frequency Measurement Test Set

Materials Required

None

1. Procedure.

a. Setup the Swept Frequency Measurement Test Set AN/USM-402(V)1 (USM-402) by doing substeps below:

(1) Position USM-402 next to aircraft to allow best access to items to be tested.

NOTE

Do not ground USM-402 to aircraft.

(2) Connect USM-402 ground cable between unpainted surface of USM-402 and good ground source.

(3) Attach Radio Frequency Recorder RO-469-(P)/USM-402(V) (recorder) to top of USM-402 using attaching straps.

(4) Obtain hookup cable W3. Connect W3P2 to 1J2 of USM-402 and W3P1 to 2J1 of recorder.

(5) On control panel, make sure POWER switch is set to OFF.

NOTE

USM-402 operates on 105 to 125vac, 50 to 400 Hz power.

Do not use aircraft 400 Hz utility power as power source for USM-402.

Figure A21.0-1 Example of Setup (continued)

Table 1. Initial Setup (Continued)

(6) Connect USM-402 power cable W1 between 1J1 and 105 to 125vac, 50 to 60 Hz power source. If 105 to 125vac, 400 Hz power source is more accessible, use adapter W2 (part of test set) to connect power cable W1 to 400 Hz power source.

(7) On control panel, set POWER switch to ON.

(8) On oscilloscope, set LINE switch to ON.

(9) On sweep oscillator, press POWER pushbutton.

CAUTION

To prevent possible detector damage, touch a ground point before handling detectors to avoid static discharge from the hands through the detector.

Do not connect detectors directly to the high frequency output of the sweep oscillator unless internal leveling (LEVELING INT) is selected on the oscillator unit. The high frequency RF output may be strong enough to damage the detectors in the unleveled mode.

b. Connect USM-402 directional couplers, and detectors to swept amplitude analyzer and oscillator using USM-402 rf cables. Use the applicable rf cables necessary to reach unit under test. Refer to fig 1.

c. On the sweep oscillator, set the below controls:

NOTE

Off is with black ring visible.

SWEEP TIME (SEC)	0.01
VARIABLE	Midrange
TRIGGER INT	On (pressed)
MANUAL SWEEP	Full CCW and pushed
RF MARKER	Off
RF AM	Off
RF BLANKING	Off
MARKER AMPL	OFF (full CCW)
Sweep Mode	Select full band by pressing center of control marked FULL BAND.
M1	Not used
ΔF	Not used
F_0 FINE	Not used
M2	Not used

d. On the oscillator unit, set the below controls:

LEVELING	INT
PM (RF OFF)	On (pressed)

Figure A21.0-1 Example of Setup (continued)

Table 1. Initial Setup (Continued)

NOTE

Countermeasures set antenna system sweep frequencies are listed in Line/Antenna Return Loss and Insertion Loss, table 1 (A1-F18AE-760-210/(S), WP003 00).

Countermeasures warning and control system sweep frequencies are listed in Line/Antenna Return Loss and Insertion Loss, table 2 (A1-F18AE-760-210/(S), WP003 00).

e. On the controller, set the below controls:

NOTE

Select the narrowest spectrum that includes selected range and sweep frequencies.

FREQ RANGE GHz	Select range and frequency scale of interest.
LEVEL CONTROL	Maximum leveled power (turn LEVEL CONTROL maximum CW until UNLEVELED WHEN LIT lamp comes on, then CCW until lamp goes out).

f. On the swept amplitude analyzer, set the below controls:

SMOOTHING	Off (out)

CHANNEL A

DISPLAY POSITION	Press
OFFSET dB	+00.0
OFFSET CAL	ON
dB/DIV	10

NOTE

CHANNEL B DISPLAY is turned off by slightly pressing one of the CHANNEL B DISPLAY pushbuttons already in the out (off) position. This action releases all pushbuttons from their detent position.

CHANNEL B

DISPLAY	Off
OFFSET db	+00.0
OFFSET CAL	ON
dB/DIV	10

g. On the oscilloscope, set the below controls:

Figure A21.0-1 Example of Setup (continued)

Table 1. Initial Setup (Continued)

DISPLAY	EXT SENS
INTENSITY	Adjust for visible trace.
FOCUS	Adjust for sharp trace (use FIND BEAM and HORIZONTAL POSITION as necessary).
SCALE	Set so that grid lines (CRT graticules) are visible.
AC/DC	DC
MAGNIFIER	X5
HORIZONTAL POSITION	Position left edge of trace on left vertical graticule.
DISPLAY	Adjust external sensitivity so that trace fills full width of horizontal scale.

h. On swept amplitude analyzer, use CHANNEL A DISPLAY POSITION screwdriver adjustment to set channel A sweep position at the second horizontal graticule from the top of the oscilloscope. (Another graticule may be selected at the option of the operator.) This is the position graticule.

NOTE

Channel A display is turned off by slightly pressing one of the CHANNEL A DISPLAY pushbuttons. This releases all pushbuttons from their detent position.

i. On the swept amplitude analyzer, turn off channel A display and press CHANNEL B DISPLAY POSITION pushbutton.

NOTE

Adjustment of oscilloscope controls is not necessary to obtain a channel B trace. If adjustment becomes necessary, this is an indication of a malfunction in the swept amplitude analyzer.

j. On swept amplitude analyzer, use screwdriver adjustment to set channel B sweep position to the same horizontal graticule used in step h.

Table 2. Insertion Loss Setup

Support Equipment Required

Part Number or Type Designation	Nomenclature
AN/USM-402A(V)1	Swept Frequency Measurement Test Set

Materials Required

None

1. Procedure.

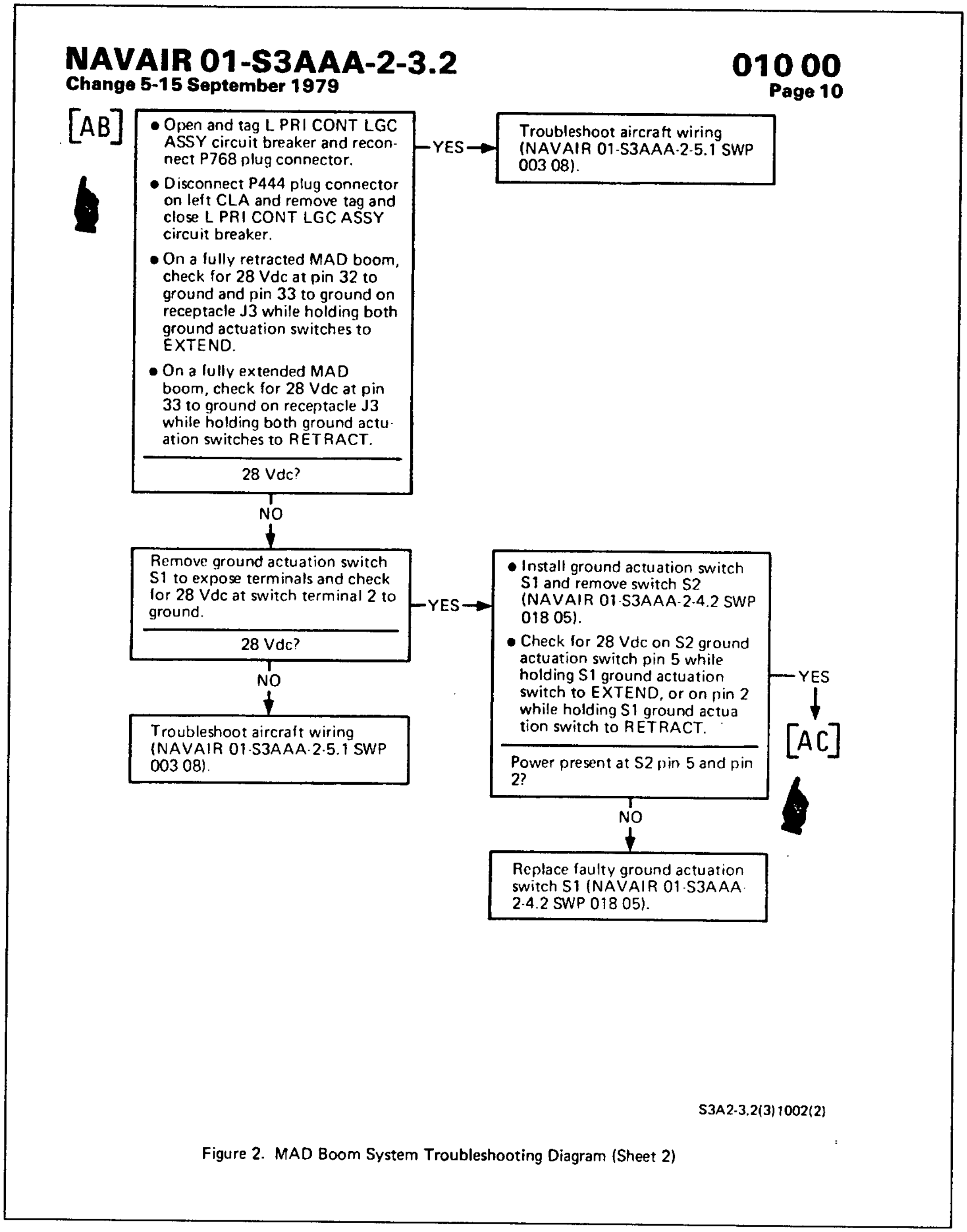
a. Use fig 1 to select USM-402 components for insertion loss setup.

Figure A21.0-1 Example of Setup (continued)

APPENDIX B: SURVEY CATEGORIES

B1.0 OCR TEST IMAGES (SECOND EVALUATION STAGE)

The following images were used in the second OCR evaluation. (See Table 4.2.4-1.) These images have been made available for viewing in case someone wanted to see why a particular OCR engine performed the way it did on a certain image in the evaluation.



NAVAIR 01-S3AAA-2-3.2 — **010 00**

Change 5-15 September 1979 — **Page 10**

[AB]

- Open and tag L PRI CONT LGC ASSY circuit breaker and reconnect P768 plug connector.
- Disconnect P444 plug connector on left CLA and remove tag and close L PRI CONT LGC ASSY circuit breaker.
- On a fully retracted MAD boom, check for 28 Vdc at pin 32 to ground and pin 33 to ground on receptacle J3 while holding both ground actuation switches to EXTEND.
- On a fully extended MAD boom, check for 28 Vdc at pin 33 to ground on receptacle J3 while holding both ground actuation switches to RETRACT.

28 Vdc?

YES → Troubleshoot aircraft wiring (NAVAIR 01-S3AAA-2-5.1 SWP 003 08).

NO ↓

Remove ground actuation switch S1 to expose terminals and check for 28 Vdc at switch terminal 2 to ground.

28 Vdc?

YES →

- Install ground actuation switch S1 and remove switch S2 (NAVAIR 01-S3AAA-2-4.2 SWP 018 05).
- Check for 28 Vdc on S2 ground actuation switch pin 5 while holding S1 ground actuation switch to EXTEND, or on pin 2 while holding S1 ground actuation switch to RETRACT.

Power present at S2 pin 5 and pin 2?

YES ↓ [AC]

NO ↓ Replace faulty ground actuation switch S1 (NAVAIR 01-S3AAA-2-4.2 SWP 018 05).

NO ↓ Troubleshoot aircraft wiring (NAVAIR 01-S3AAA-2-5.1 SWP 003 08).

S3A2-3.2(3)1002(2)

Figure 2. MAD Boom System Troubleshooting Diagram (Sheet 2)

Figure B1.0-1 NAVAIR 01-S3AAA-2-3.2 10-00p10

[AC]

- Install ground actuation switch S2 and disconnect P464 plug connector on left CLA.
- Check for 28 Vdc at pin 20 of P464 plug connector while holding both ground actuation switches to EXTEND.

28 Vdc?

YES → Verify SP23 proximity switch operation (NAVAIR 01-S3AAA-2-4.2 SWP 018 05).

SP23 operational?

YES → Troubleshoot left CLA (NAVAIR 01-S3AAA-2-3.11 WP 008 00).

NO → Replace SP23 proximity switch (NAVAIR 01-S3AAA-2-4.2 SWP 018 05).

NO → Troubleshoot aircraft wiring (NAVAIR 01-S3AAA-2-5.1 SWP 003 08).

[B]

Boom retracts but will not extend.

NO ↓

- Open and tag MAD BOOM ACTR ØAØBØC circuit breaker and disconnect P446 and P440 plug connectors from left relay panel.
- Check for continuity between pin HH on receptacle J2, and pin ZD on receptacle J4 while holding both ground actuation switches to EXTEND.

Continuity?

NO → [BA]

YES → **[BB]**

CAUTION

Use nonmagnetic tools in the area of the MAD boom. For specific instruction on magnetic cleanliness control refer to NAVAIR 01-S3AAA-2-4.2 SWP 018 01.

Disconnect actuator cable (NAVAIR 01-S3AAA-2-4.2 SWP 018 01) and move MAD boom fore and aft slowly. Check for mechanical freedom of rollers on rails, unrestricted cable retractor movement, and minimal friction through tail cone seal. Do not install safety pin (NAVAIR 01-S3AAA-2-4.2 SWP 018 03.)

Can MAD boom be extended without undue force to overcome friction of rear seal and emergency inertia brake?

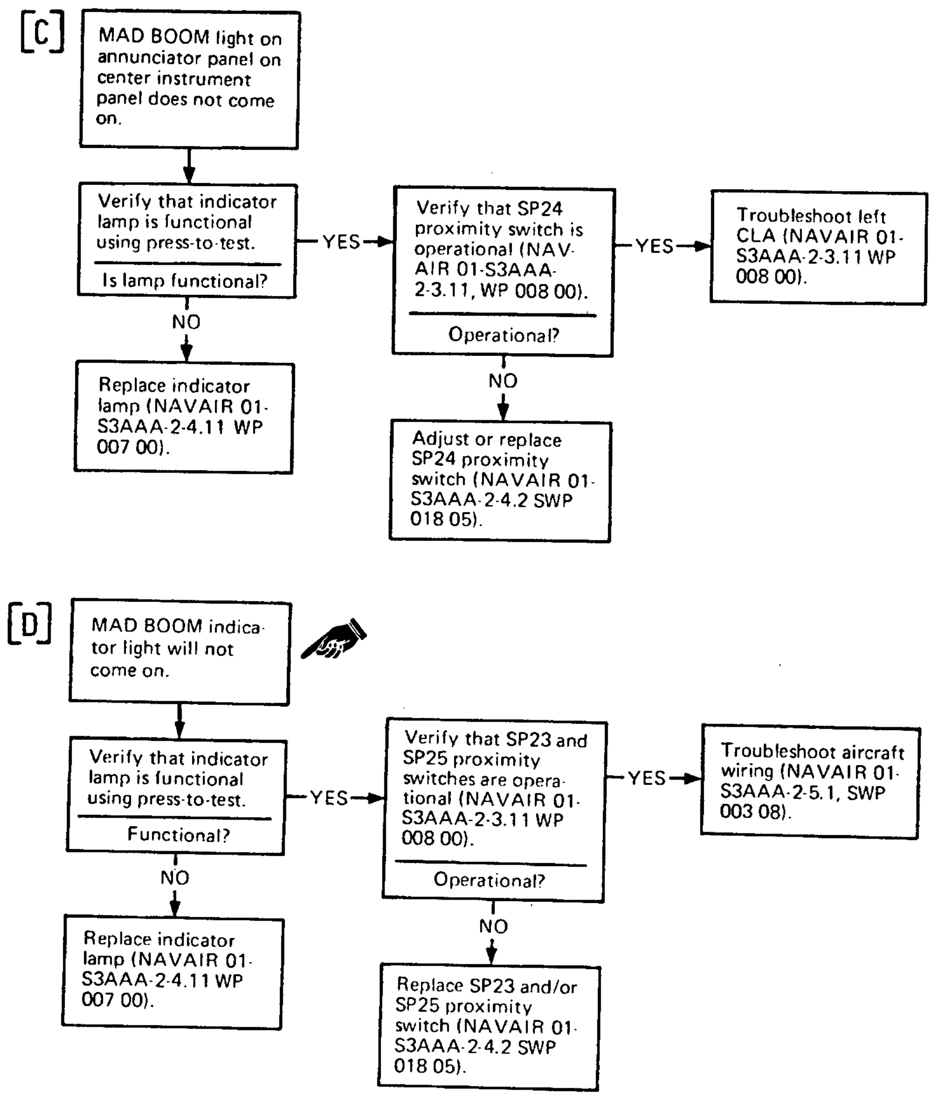
YES → Replace MAD boom rotary actuator drive motor (NAVAIR 01-S3AAA-2-4.2 SWP 018 02)

NO → [BC]

S3A2 3.2(3)1002(3)

Figure 2. MAD Boom System Troubleshooting Diagram (Sheet 3)

Figure B1.0-2 NAVAIR 01-S3AAA-2-3.2 10-00p11



S3A2-3.2(3)1002(5)

Figure 2. MAD Boom System Troubleshooting Diagram (Sheet 5)

Figure B1.0-3 NAVAIR 01-S3AAA-2-3.2 10-00p13

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No.	Date Incorp.	Remarks
AFC-168	—	INSTRUMENT SYSTEMS: Relocation of Cockpit Caution/Warning Lights (ECP S3-352)	10-01-83	ECP Coverage Only
AFC-172	01-23-80	NONACOUSTIC SENSORS: Improvement of MAD Boom Electrical Cable Retractor Installation. (RAMEC P-007-79)	01-01-92	—
AFC-186	04-22-81	ELECTRICAL SYSTEMS: Color Coding of Selective Circuit Breakers for Increased WRA MTBF (RAMECP-14-80)	04-01-83	—

1. INTRODUCTION.

2. Testing and troubleshooting of the MAD boom system consists of pretest setup, functional checkout, and shutdown procedures. Bracketed upper-case letters in the functional checkout procedures key malfunction symptoms to associated logic-tree troubleshooting diagrams. Logic-tree troubleshooting diagrams assume that only one malfunction exists at a time. After correcting a malfunction or replacing a Weapon Replaceable Assembly (WRA), the functional checkout procedure must be repeated. Additional troubleshooting data is presented in the form of an electrical schematic (figure 3) and power distribution diagrams (NAVAIR 01-S3AAA-2-3.11 SWP 003 01 and WP 005 00).

3. Each WRA of the MAD boom system needed for testing and troubleshooting is listed in table 1 and are shown in figure 1.

TABLE 1. WEAPON REPLACEABLE ASSEMBLIES

Nomenclature	Location	Common Name	Qty
	MAD Boom System		
MAD Boom Assembly	ECS compartment	MAD Boom	1
MAD Boom Rotary Actuator Assembly	ECS compartment	Actuator	1
MAD Boom Rotary Actuator Motor	ECS compartment	Motor	1

Figure B1.0-4 NAVAIR 01-S3AAA-2-3.2 10-00p2

TABLE 1. WEAPON REPLACEABLE ASSEMBLIES (CONT)

Nomenclature	Location	Common Name	Qty
Cable Drum	ECS compartment	Drum	1
MAD Boom Actuator Cable Assembly	ECS compartment	Actuator cable	1
MAD Boom Phenolic Clamping Block	ECS Compartment	Clamping block	1
MAD Boom Pulley Tripod Assembly	ECS compartment	Tripod	1
MAD Boom Roller Support Assembly	ECS compartment	Roller support	2
Rollers	ECS compartment	Rollers	6
Emergency Inertia Brake	Aft fuselage	Emergency inertia brake	1
MAD Boom Extended Proximity Switch Assembly	Aft fuselage	Extended proximity switch (SP23)	1
MAD Boom Retracted Proximity Switch Assembly	Aft fuselage	Retracted proximity switch (SP24)	1
MAD Boom Not-Retracted Proximity Switch Assembly	Aft fuselage	Not-retracted proximity switch (SP25)	1
Ground Actuation Switch Assembly	Right aft external avionics bay and ECS compartment	Ground actuation switch	2
MAD Boom Electrical Cable Retractor	ECS compartment	Cable retractor	1
MAD Boom Control Panel	Copilot's side console	MAD BOOM CONTROL panel	1
	Associated Equipment		
Light Control Panel	Copilot's side console	LIGHT CONTROL panel	1
Left Control Logic Assembly	Left electrical load center	Left CLA	1

Figure B1.0-5 NAVAIR 01-S3AAA-2-3.2 10-00p3

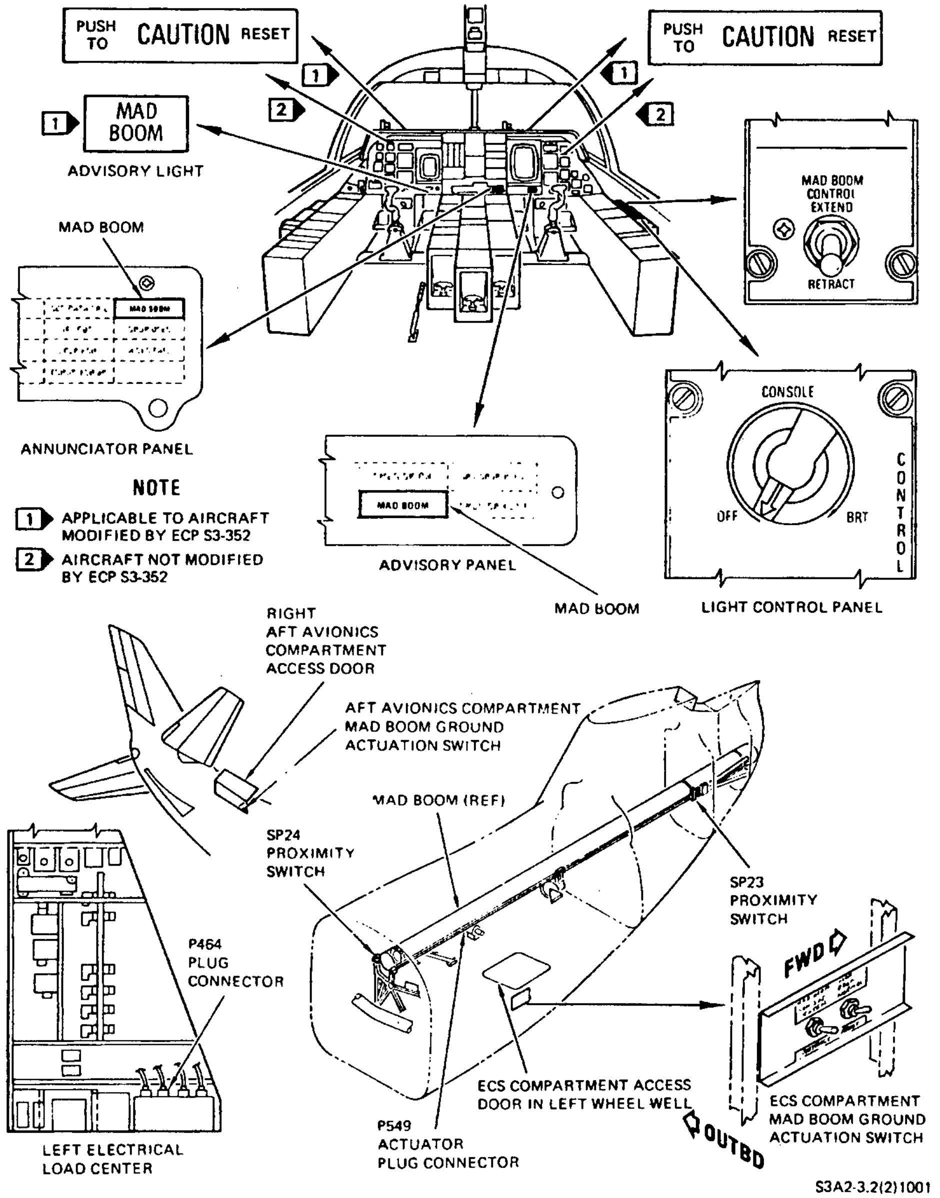


Figure 1. MAD Boom System Controls and Components Location Diagram

Figure B1.0-6 NAVAIR 01-S3AAA-2-3.2 10-00p4

4. Figure 2 contains probable malfunctions in logic-tree diagram format. Figure 3 is an electrical schematic of the system. Wiring data for the MAD boom system is provided in NAVAIR 01-S3AAA-2-5.1 SWP 003 08.

5. TESTING AND TROUBLESHOOTING.

Support Equipment

Part number	Nomenclature
AN/USM-311	Multimeter
BD41-101	Kit Test Set
BD01-105	Logic Test Set
NC-2A	Mobile Electric Powerplant (Carrier)
NC-8A	Mobile Electric Powerplant (Land)
NR-5C	Air Conditioner (Carrier)
NR-10	Air Conditioner (Land)

6. PRETEST SETUP.

WARNING

Before turning on electrical power, ensure that all electrical access panels are closed and personnel have been alerted that electrical power will be turned on.

CAUTION

When electrical power is to be applied, the need to turn on air conditioning depends upon ambient temperature criterion stated in NAVAIR 01-S3AAA-2-1 SWP 007 12.

NOTE

To extend life of equipment, open all color coded circuit breakers, other than those required for specific maintenance procedures, before applying electrical power.

a. Connect and turn on NC-2A or NC-8A Mobile Electric Powerplant (NAVAIR 01-S3AAA-2-1 SWP 007 10), as applicable, and NR-5C or NR-10 Air Conditioner (NAVAIR 01-S3AAA-2-1 SWP 007 12), as applicable.

b. Ensure that circuit breakers listed in table 2 are closed.

c. Refer to table 3 for control relay and proximity switch designation and function, table 4 for left CLA input/output signals, and table 5 for control logic equations.

7. FUNCTIONAL CHECKOUT.

a. Set CONSOLE switch on LIGHT CONTROL panel on Copilot's side console to BRT (figure 1). MAD BOOM CONTROL panel edge-lighted panel light must come on. If edge-lighting does not come on, replace lamps or troubleshoot aircraft wiring (NAVAIR 01-S3AAA-2-5.1 WP 003 08).

b. Open and tag L PRI CONT LGC ASSY circuit breaker on left hinged circuit breaker panel.

c. Open left electrical load center, and remove P464 plug connector from left CLA (figure 1).

TABLE 2. CIRCUIT BREAKERS

Circuit Breaker	Circuit Breaker Panel
CONSOLE LT DIMMER COPILOT ϕB	Right hinged
ADVISORY LIGHT PANEL	Right fixed
MAD BOOM ACTR ϕAϕBϕC	Left fixed
CAUTION LIGHT PANEL	Right fixed
MASTER CAUTION LIGHT	Right fixed

d. Remove tag and close L PRI CONT LGC ASSY circuit breaker.

e. Set MAD boom switch on MAD BOOM CONTROL panel to EXTEND (figure 1).

Figure B1.0-7 NAVAIR 01-S3AAA-2-3.2 10-00p5

switch located on forward left side of ECS compartment.

l. Open right aft avionics compartment access door, and station one man at aft avionics compartment; have him stand by MAD boom ground actuation switch located on forward bulkhead. This man must signal for MAD boom extension, since his view of MAD boom and area behind aircraft is unobstructed.

m. Operate both MAD boom ground actuation switches to EXTEND. Following results must be obtained:

(1) MAD boom extends.

Figure 2 [A] [B]

(2) CAUTION indicator lights flash. In aircraft modified by ECP S3-352, CAUTION indicator lights are located under Pilot's and Copilot's glareshield. In aircraft not modified by ECP S3-352, CAUTION indicator lights are located on Pilot's and Copilot's instrument panels.

(3) MAD BOOM indicator light on annunciator panel on center instrument panel comes on (amber).

Figure 2 [C]

(4) At full extension, MAD BOOM indicator light comes on (green). In aircraft modified by ECP S3-352, MAD BOOM indicator light is located on Pilot's instrument panel and Copilot's advisory panel. In aircraft not modified by ECP S3-352, MAD BOOM indicator light is located on Copilot's advisory panel.

Figure 2 [D]

NOTE

Either MAD boom ground actuation switch, when released, will stop MAD boom movement.

n. Operate both MAD boom ground actuation switches to RETRACT. Following results must be obtained:

(1) MAD boom retracts.

Figure 2 [E]

(2) MAD BOOM indicator light goes off. In aircraft modified by ECP S3-352, MAD BOOM indicator light is located on Pilot's instrument panel and Copilot's advisory panel. In aircraft not modified by ECP S3-352, MAD BOOM indicator light is located on Copilot's advisory panel.

Figure 2 [F]

(3) At full retraction, CAUTION indicator lights go off. In aircraft modified by ECP S3-352, CAUTION indicator lights are located under Pilot's and Copilot's glareshield. In aircraft not modified by ECP S3-352, CAUTION indicator lights are located on Pilot's and Copilot's instrument panels.

Figure 2 [G]

(4) MAD BOOM indicator light on annunciator panel goes off.

Figure 2 [G]

o. Operate both MAD boom ground actuation switches to EXTEND until MAD boom is fully extended and then to RETRACT until MAD boom is fully retracted, and check for the following:

(1) Electrical cable retractor reel reels in and reels out cable freely with no signs of slack in cable.

Figure 2 [H]

(2) Electrical cable clears corners of upper outboard flange of cable retractor reel when cable is transitioning through slot between flanges.

Figure 2 [I]

8. SHUTDOWN.

a. Shut down and disconnect NC-2A or NC-8A Mobile Electric Powerplant (NAVAIR 01-S3AAA-2-1 SWP 007 10), as applicable, and NR-5C or NR-10 Air Conditioner, (NAVAIR 01-S3AAA-2-1 SWP 007 12), as applicable.

b. *Check access area for cleanliness, security of components, and for removal of foreign objects.*

c. *Close right aft avionics compartment access door and ECS compartment access door.*

Figure B1.0-8 NAVAIR 01-S3AAA-2-3.2 10-00p8

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001 00
Page 1

ORGANIZATIONAL MAINTENANCE
TESTING AND TROUBLESHOOTING

ALPHABETICAL INDEX

FORWARD LOOKING INFRARED SYSTEM

AN/AAS-38, AN/AAS-38A, AND AN/AAS-38B

Figure B1.0-9 A1-F18AC-744-210 1-00p1

1. INTRODUCTION.

2. Testing and troubleshooting of the counting accelerometer consists of a visual inspection, a comparative analysis of the last periodic recording in the aircraft log, known load levels during flight, and troubleshooting aircraft wiring (NAVAIR 01-S3AAA-2-5.1 SWP 003 10). System discrepancies such as improper grounds or shielding, connector pin wear and power interruptions can cause false readings on the indicator.

3. The Weapon Replaceable Assemblies (WRA) of the counting accelerometer is listed in table 1 and is shown in figure 1. Procedures for replacing each WRA is contained in NAVAIR 01-S3AAA-2-4.2 SWP 004 09.

4. TESTING AND TROUBLESHOOTING.

5. For this type of transducer, windows in the indicator will record number of events of a particular magnitude. Window 1 records number of times that 2-g's have been reached in a vertical plane. Windows 2, 3, and 4 will record occurrences of 2.5, 3.0, and 3.5-g levels, respectively.

6. Visually inspect counting windows (figure 1), and verify that counts are greater than those recorded in aircraft log at last periodic inspection. Ensure that counts are highest in window 1, and progressively lower in windows 2, 3, and 4. The system will be checked each time readings are taken for malfunctions such as no counts, erratic counts and excessive counts using the following procedures.

7. If no counts have been registered since last periodic inspection, and aircraft has performed maneuvers that would result in g-loads equal to or higher than 2.0 g (showing in window 1), check for the following:

a. Proper Transducer MS part number. Inspect nameplate of transducer for proper MS part number. If incorrect, replace transducer (NAVAIR 01-S3AAA-2-4.2 SWP 004 09) with correct unit and submit NAVAIR Form 13920/1.

b. Mismatch of Transducer and Indicator. Inspect nameplates for mismatch of indicator and transducer manufacturer. If mismatched, remove either indicator or transducer (NAVAIR 01-S3AAA-2-4.2 SWP 004 09), replace with unit matching the manufacturer of remaining unit and submit NAVAIR Form 13920/1. Comply with 7.c below if required.

c. Unmodified Giannini Indicator. If no mismatch and units are both manufactured by Giannini, check for unmodified indicator. Unmodified units will have Giannini Part No. 2231-B-1. Modified units will have Giannini Part No. 2231-B-2. If unmodified, replace indicator (NAVAIR 01-S3AAA-2-4.2 SWP 004 09) and submit NAVAIR Form 13920/1.

d. No power to system with MLG up and locked. If indicator is of modified type, check for 28 vdc power to pin 1 of P127 using pin 2 of P127 for ground (NAVAIR 01-S3AAA-2-5.1 SWP 003 11) with RH main landing gear in a (simulated) up and locked condition (1F0 output from LH Control Logic Assy). If no power is available, correct as required and submit NAVAIR Form 13920/1.

e. Faulty system connectors or wiring. If proper power is available to P127, inspect indicator and transducer receptacles for pin and socket condition (loose, worn, pushed, etc.), indicator to transducer wiring condition, pin-to-pin continuity and proper shield connections. If faulty, correct or replace as necessary and submit NAVAIR Form 13920/1.

8. If none of the discrepancies described in 7.a through 7.e exists, replace Transducer and Indicator (NAVAIR 01-S3AAA-2-4.2 SWP 004 09) and submit NAVAIR Form 13920/1.

9. If erratic counts are being registered, it should be verified by comparing the previous periods readings on all four windows with the current window readings. The highest number should be in window 1 and lower in each successive window. If the counts for a given load level exceed the previous periods readings for a lower load level, erratic readings are being recorded. Examples would be if window 4 counts exceeds counts of windows 3, 2 and 1 or window 3 counts exceed counts of windows 2 and 1. If this condition exists, check for the following:

Figure B1.0-10 NAVAIR 01-S3AAA-2-3.2 1-00p2

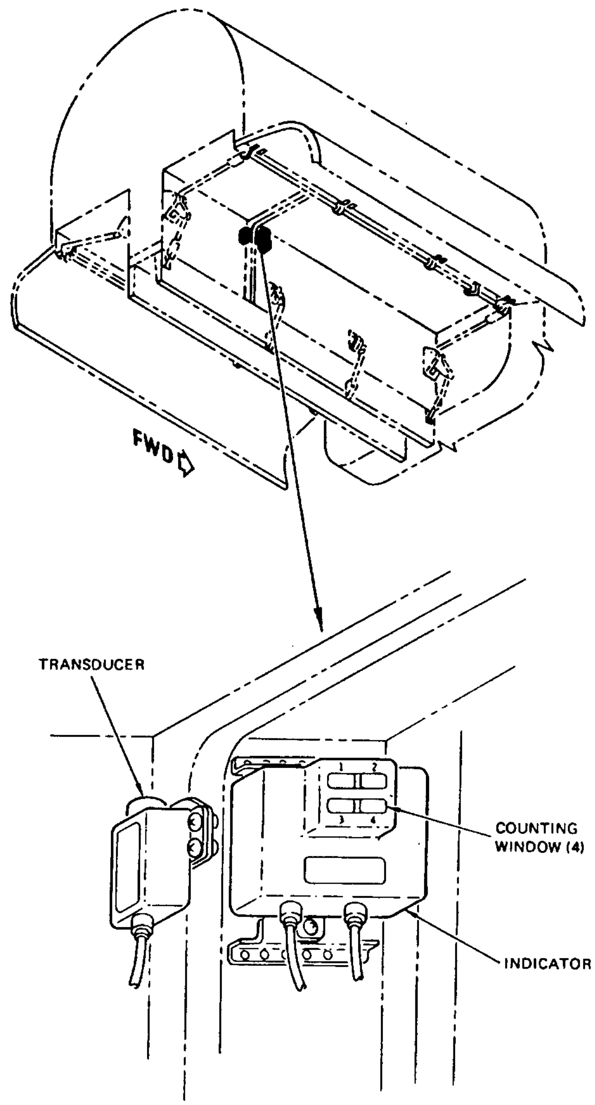

Figure 1. Counting Accelerometer Components Location Diagram (on Aircraft Not Modified by AFC-221)

Figure B1.0-11 NAVAIR 01-S3AAA-2-3.2 11-00p3

INTRODUCTION

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

HYDRAULIC SYSTEM

1. PURPOSE.

2. This manual provides the data required by the technician to do testing and troubleshooting of the system.

3. REQUISITIONING AND DISTRIBUTION OF NAVAIR TECHNICAL PUBLICATIONS.

4. Procedures to be used by Naval Activities and other Department of Defense organizations requiring NAVAIR technical publications are defined in the NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM manual, NAVAIR 00-25-100 and NAVAIRINST 5605.5, Distribution of aeronautic technical publications. To automatically receive future changes and revisions to NAVAIR technical manuals, an activity must be established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Services Facility (NAVAIRTECHSERVFAC). To become established on the ADRL, notify your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution requirements by contacting the Commanding Officer, NAVAIRTECHSERVFAC, Attn: ADRL REQUEST, 700 Robbins Avenue, Philadelphia, PA 19111-5097. Annual reconfirmation of these requirements are necessary to remain on automatic distribution. Please use your NAVAIRTECHSERVFAC assigned account number whenever referring to automatic distribution requirements.

If additional or replacement copies of this manual are required with no attendant changes in the ADRL, they may be ordered by submitting a DD 1348 requisition directly to the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Road, Philadelphia, PA 19120-5099.

5. MANUAL ISSUE DATE.

6. The date on the title page is the copy freeze date. No additions, deletions, or changes are made after the manual issue date except last minute safety of flight or required maintenance changes. Data collected after the manual issue date will be included in later changes or revisions of the manual.

7. EFFECTIVITIES.

8. Effectivity notes on manual title pages, work package title pages, and within a work package indicate the aircraft or software program to which the data applies. If no effectivity note appears on the work package title page, the work package has the same effectivity as shown on the manual title page. The effectivity notes may use:

NOTE

Aircraft with model designator F/A-18B are the same type and model as TF/A-18A.

a. Type, model, and series

NOTE

F/A-18D aircraft after bureau number 164967 is referred to as bureau number F/A-18D D-140.

b. Bureau number (tail number)

c. Combination of type, model, series, and bureau numbers

d. Part number or serial number

e. Technical directive number

f. Configuration/identification number

DA-200C11

Figure B1.0-12 A1-F18AC-450-200 2-00p1

INTRODUCTION

ORGANIZATIONAL MAINTENANCE

TESTING AND TROUBLESHOOTING

INSTRUMENT SYSTEM

1. PURPOSE.

2. This manual provides the data required by the technician to do testing and troubleshooting of the system.

3. REQUISITIONING AND DISTRIBUTION OF NAVAIR TECHNICAL PUBLICATIONS.

4. Procedures to be used by Naval Activities and other Department of Defense organizations requiring NAVAIR technical publications are defined in the NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM manual, NAVAIR 00-25-100 and NAVAIRINST 5605.5, Distribution of aeronautic technical publications. To automatically receive future changes and revisions to NAVAIR technical manuals, an activity must be established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Services Facility (NAVAIRTECHSERVFAC). To become established on the ADRL, notify your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution requirements by contacting the Commanding Officer, NAVAIRTECHSERVFAC, Attn: ADRL REQUEST, 700 Robbins Avenue, Philadelphia, PA 19111-5097. Annual reconfirmation of these requirements are necessary to remain on automatic distribution. Please use your NAVAIRTECHSERVFAC assigned account number whenever referring to automatic distribution requirements.

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NOTE

Aircraft with model designator F/A-18B are the same type and model as TF/A-18A.

a. Type, model, and series

b. Bureau number (tail number)

c. Combination of type, model, series, and bureau numbers

d. Part number or serial number

e. Technical directive number

DA-200C9

Figure B1.0-13 A1-F18AC-510-200 2-00p1

9. The table below shows examples of effectivity notes and their meanings:

Effectivity Note Examples

Effectivity Note	Definition
160777 AND UP	Applicable to all F/A-18A, F/A-18B, F/A-18C and F/A-18D for bureau numbers listed.
F/A-18A, F/A-18B	Applicable to all F/A-18A and F/A-18B.
F/A-18C, F/A-18D	Applicable to all F/A-18C and F/A-18D.
F/A-18A	Applicable to all F/A-18A, but not F/A-18B, F/A-18C and F/A-18D.
F/A-18B	Applicable to all F/A-18B, but not F/A-18A, F/A-18C, and F/A-18D.
F/A-18C	Applicable to all F/A-18C, but not F/A-18A, F/A-18B, and F/A-18D.
F/A-18D	Applicable to all F/A-18D, but not F/A-18A, F/A-18B, and F/A-18C.
F/A-18A, F/A-18C	Applicable to all F/A-18A and F/A-18C, but not to F/A-18B and F/A-18D.
F/A-18B, F/A-18D	Applicable to all F/A-18B and F/A-18D, but not to F/A-18A and F/A-18C.
F/A-18A 160775, 160777 THRU 160782	Only applicable to some bureau numbers of F/A-18A. Not applicable to any F/A-18B, even if a F/A-18B bureau number is within the numbers listed.
F/A-18C 163427, 163430 THRU 163456	Only applicable to some bureau numbers of F/A-18C. Not applicable to any F/A-18D, even if a F/A-18D bureau number is within the numbers listed.
F/A-18B 160784 AND UP	Only applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed.
F/A-18D 163434 THRU 163457	Only applicable to some bureau numbers of F/A-18D. Not applicable to any F/A-18C, even if a F/A-18C bureau number is within the numbers listed.
F/A-18B 160784 AND UP, F/A-18D	Applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed. Also applicable to all F/A-18D aircraft.

Figure B1.0-14 A1-F18AC-450-200 2-00p2

f. Configuration/identification number

9. The table below shows examples of effectivity notes and their meanings:

Effectivity Note Examples

Effectivity Note	Definition
160777 AND UP	Applicable to all F/A-18A, F/A-18B, F/A-18C and F/A-18D for bureau numbers listed.
F/A-18A, F/A-18B	Applicable to all F/A-18A and F/A-18B.
F/A-18C, F/A-18D	Applicable to all F/A-18C and F/A-18D.
F/A-18A	Applicable to all F/A-18A, but not F/A-18B, F/A-18C and F/A-18D.
F/A-18B	Applicable to all F/A-18B, but not F/A-18A, F/A-18C, and F/A-18D.
F/A-18C	Applicable to all F/A-18C, but not F/A-18A, F/A-18B, and F/A-18D.
F/A-18D	Applicable to all F/A-18D, but not F/A-18A, F/A-18B, and F/A-18C.
F/A-18A, F/A-18C	Applicable to all F/A-18A and F/A-18C, but not to F/A-18B and F/A-18D.
F/A-18B, F/A-18D	Applicable to all F/A-18B and F/A-18D, but not to F/A-18A and F/A-18C.
F/A-18A 160775, 160777 THRU 160782	Only applicable to some bureau numbers of F/A-18A. Not applicable to any F/A-18B, even if a F/A-18B bureau number is within the numbers listed.
F/A-18C 163427, 163430 THRU 163456	Only applicable to some bureau numbers of F/A-18C. Not applicable to any F/A-18D, even if a F/A-18D bureau number is within the numbers listed.
F/A-18B 160784 AND UP	Only applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed.
F/A-18D 163434 THRU 163457	Only applicable to some bureau numbers of F/A-18D. Not applicable to any F/A-18C, even if a F/A-18C bureau number is within the numbers listed.

Figure B1.0-15 A1-F18AC-510-200 2-00p2

established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Services Facility (NAVAIRTECH-SERVFAC). To become established on the ADRL, notify your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution requirements by contacting the Commanding Officer, NAVAIRTECHSERVFAC, Attn: ADRL REQUEST, 700 Robbins Avenue, Philadelphia, PA 19111-5097. Annual reconfirmation of these requirements is necessary to remain on automatic distribution. Please use your NAVAIRTECHSERVFAC assigned account number whenever referring to automatic distribution requirements.

6. If additional or replacement copies of this manual are required with no attendant changes in the ADRL, they may be ordered by submitting a DD 1348 requisition directly to the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Road, Philadelphia, PA 19120-5099.

7. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

8. The technical directives affecting this manual are listed in the Record of Applicable Technical Directives of each affected work package. When all affected targeting FLIR systems are modified, the before configuration and the technical directive entry are removed from the affected work package.

9. TROUBLESHOOTING IMPROVEMENTS.

10. When a troubleshooting procedure does not correct a malfunction and you determine that additional or new troubleshooting is required, submit a Technical Publications Deficiency Report (TPDR) providing the information below:

a. Fault descriptor for A1-F18( )-FRM-000.

b. Corrective action taken for malfunction.

Figure B1.0-16 A1-F18AC-744-210 2-00p2

Effectivity Note Examples (Continued)

Effectivity Note	Definition
F/A-18C, F/A-18D 163434 THRU 163457	Applicable to all F/A-18C aircraft. Applicable to some bureau numbers of F/A-18D.
F/A-18D D-140 AND UP	Applicable to all F/A-18D aircraft after bureau number 164967.
160775 THRU 160785 BEFORE F/A-18 AFC 772	Applicable to F/A-18A and F/A-18B for bureau numbers listed, before modification by technical directive.
161213 AND UP; ALSO 160775 THRU 160785 AFTER F/A-18 AFC 772	Applicable to aircraft modified during production; also applicable when affected aircraft have been modified by technical directive.
160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-X IS INSTALLED	Applicable to F/A-18A and F/A-18B for bureau numbers listed if panel P/N XXXX-X is installed. (Configuration before AVC)
161213 AND UP; ALSO 160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-Y (AVC-102) IS INSTALLED	Applicable to aircraft modified during production; also applicable to aircraft components modified to the production configuration by technical directive. (Configuration after AVC)
P/N MBEU65101-9, MBEU65101-10 & MBEU65105-3	Applicable to assemblies which are interchangeable between aircraft.
ENGINE NO. 215101 THRU 215109	Applicable to assemblies which are interchangeable between aircraft, but configurations can not be identified by part number.
CONFIG/IDENT NUMBER 84A	The CONFIG/IDENT Number is the program load identification number which identifies the software program loaded in specific programmable units. Refer to A1-F18AC-SCM-000 for CONFIG/IDENT Number tables.

10. TECHNICAL DIRECTIVES.

11. Technical directives are documents which direct the accomplishment, and recording of a retrofit configuration or inspection to delivered aircraft, or aircraft components.

12. **AIRFRAME CHANGE (AFC) AND AIRBORNE TACTICAL SOFTWARE CHANGE (ASC) .** Technical directives which change configuration of aircraft structure or equipment installation, i.e. AFC, will list aircraft bureau numbers in effectivity notes and show before and after the AFC. Technical directives which change configuration of operational flight programs (OFP), i.e. ASC, will list the OFP CONFIG/IDENT NUMBER in effectivity notes and show the latest two authorized OFP programs. See AFC and ASC effectivity examples in Effectivity Note Example Table.

13. **AIRCRAFT COMPONENT CHANGES.** Technical directives which change configuration of aircraft components, i.e. AAC, ACC, AVC, AYC, and PPC will list part numbers in the effectivities. See AVC effectivity examples in Effectivity Note Example table.

14. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

15. The technical directives affecting this manual are listed in the Record of Applicable Technical

Figure B1.0-17 A1-F18AC-450-200 2-00p3

Effectivity Note Examples (Continued)

Effectivity Note	Definition
F/A-18B 160784 AND UP, F/A-18D	Applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed. Also applicable to all F/A-18D aircraft.
F/A-18C, F/A-18D 163434 THRU 163457	Applicable to all F/A-18C aircraft. Applicable to some bureau numbers of F/A-18D.
160775 THRU 160785 BEFORE F/A-18 AFC 772	Applicable to F/A-18A and F/A-18B for bureau numbers listed, before modification by technical directive.
161213 AND UP; ALSO 160775 THRU 160785 AFTER F/A-18 AFC 772	Applicable to aircraft modified during production; also applicable when affected aircraft have been modified by technical directive.
160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-X IS INSTALLED	Applicable to F/A-18A and F/A-18B for bureau numbers listed if panel P/N XXXX-X is installed. (Configuration before AVC)
161213 AND UP; ALSO 160775 THRU 160785; WHEN NO. 2 CONTROL PANEL P/N XXXX-Y (AVC-102) IS INSTALLED	Applicable to aircraft modified during production; also applicable to aircraft components modified to the production configuration by technical directive. (Configuration after AVC)
P/N MBEU65101-9, MBEU65101-10 & MBEU65105-3	Applicable to assemblies which are interchangeable between aircraft.
ENGINE NO. 215101 THRU 215109	Applicable to assemblies which are interchangeable between aircraft, but configurations can not be identified by part number.
CONFIG/IDENT NUMBER 84A	The CONFIG/IDENT Number is the program load identification number which identifies the software program loaded in specific programmable units. Refer to A1-F18AC-SCM-000 for CONFIG/IDENT Number tables.

10. **TECHNICAL DIRECTIVES.**

11. Technical directives are documents which direct the accomplishment, and recording of a retrofit configuration or inspection to delivered aircraft, or aircraft components.

12. **AIRFRAME CHANGE (AFC) AND AIRBORNE TACTICAL SOFTWARE CHANGE (ASC).** Technical directives which change configuration of aircraft structure or equipment installation, i.e. AFC, will list aircraft bureau numbers in effectivity notes and show before and after the AFC. Technical directives which change configuration of operational flight programs (OFP), i.e. ASC, will list the OFP CONFIG/IDENT NUMBER in effectivity notes and show the latest two authorized OFP programs. See AFC and ASC effectivity examples in Effectivity Note Example Table.

13. **AIRCRAFT COMPONENT CHANGES.** Technical directives which change configuration of aircraft components, i.e. AAC, ACC, AVC, AYC, and PPC will list part numbers in the effectivities. See AVC effectivity examples in Effectivity Note Example table.

Figure B1.0-18 A1-F18AC-510-200 2-00p3

Directives of each affected work package. Because an ASC directs all aircraft be modified within 30 days, ASC's are not listed. When all affected aircraft are modified, the before configuration is removed from the manual, and the technical directive entry is removed from the Record of Applicable Technical Directives.

16. TECHNICAL PUBLICATIONS DEFICIENCY REPORT (TPDR).

17. The TPDR (OPNAV FORM 4790/66) is the form for reporting errors and suspected omissions in the technical manuals. Reporting procedures are in OPNAVINST 4790.2 SERIES.

18. QUALITY ASSURANCE PROCEDURES.

19. Procedures or parts of procedures which require quality assurance inspection are identified by the letters (QA) after the applicable steps. When (QA) is assigned to a step or a heading which is immediately followed by substeps, the inspection requirement is applicable to all substeps.

20. When doing maintenance in any area, a visual inspection of the area will be made for cracks, corrosion and security of component installation before securing the area for flight.

21. TEST PROCEDURES.

22. Test procedures are done as part of malfunction isolation, during periodic inspection, or when correct system operation is to be verified.

23. Satisfactory completion of test procedures verifies correct system operation. Do steps in sequence. When doing system test procedures, make sure:

a. System Required Components identified in procedure are installed.

b. Related Systems Required identified in procedure are operative.

c. Steps are done in sequence.

d. Results are as shown in Normal Indication column, or do Remedy for Abnormal Indication.

e. Each malfunction is corrected before going to next step by repeating portion of test procedure which failed.

24. TROUBLESHOOTING.

25. **TROUBLESHOOTING PROCEDURES.** These procedures provide a series of steps with a NO-YES column. These steps lead to corrective action for the malfunction. Troubleshooting procedures list the data below for use as an aid when doing procedural steps:

a. Reference to a system schematic.

b. Reference to a component locator.

c. List of support equipment and materials required which will always be used in the procedure. Additional support equipment may be required.

d. An alphabetical list of components which could cause the malfunction.

26. Troubleshooting procedures (logic trees) are referenced from a test procedure Remedy for Abnormal Indication column or from Fault Reporting Manual. Logic trees are written assuming the logic below:

a. If doing a test procedure, all steps testing functions before the failed step had normal indication.

b. For an abnormal indication, only one malfunction exists.

c. All replacement components are ready for installation.

27. **CONTINUITY TESTING.** When doing continuity tests during troubleshooting, the items listed below must be tested, as applicable.

a. Loose electrical connectors and bent, broken, or recessed pins.

b. Continuity between specific pins per procedural step or system schematic.

c. Shorts between conductor and shield.

d. Shorts between conductor and surrounding pins on connectors.

e. Shield continuity per diagrams/system schematics.

28. **TROUBLESHOOTING BEYOND BIT/SYSTEM TESTING.** This is required when any of the conditions listed below exist:

Figure B1.0-19 A1-F18AC-450-200 2-00p4

a. Malfunction was not detected by Built-In Test (BIT).

b. Malfunction was not detected by a functional test procedure.

c. When a troubleshooting procedure did not correct the malfunction.

d. When a troubleshooting procedure does not exist.

29. When any of the conditions listed in paragraph 28 exist, troubleshooting procedure/logic must then be determined. Use steps listed below to aid in determining procedure/logic:

a. Use referenced system schematic or select applicable system schematic for malfunction. Use schematic for troubleshooting beyond BIT analysis as listed below:

(1) Analyze interface of system components. Determine logic wiring and/or components which may cause the malfunction. Determine when an interfacing component could cause the malfunction.

(2) When malfunction can be caused by mission computer system signal interface, analyze mission computer system integrated functions and memory inspect suspected Input/Output REF CODES (A1-F18AC-FIM-100).

b. Review VIDS/MAF (OPNAV 4790/60) in Aircraft Discrepancy Book for related malfunctions.

(1) Analyze system/related system maintenance codes reported by Nose Wheelwell Digital Display Indicator.

(2) Determine if aircraft components that have been replaced could cause malfunction.

(3) When a repeat malfunction exists, analyze previous maintenance action completed for the malfunction.

(a) When component replacement is/was done, analyze component history as listed:

1) Determine where component came from.

2) Determine previous history of component (when available).

3) Determine if similar malfunction occurred on another aircraft.

4) Determine if replaced component could be causing existing malfunction.

5) Determine if replacing component again would correct malfunction.

(b) Determine if any rigging or control procedures that have been done could cause the malfunction.

(c) Determine when rigging/boresight procedures should be done to verify system operation for malfunction.

30. **TROUBLESHOOTING IMPROVEMENTS.** When a troubleshooting procedure did not correct a malfunction and it is determined that additional or new troubleshooting is required, submit Technical Publications Deficiency Report (TPDR) providing the information listed below:

a. Fault descriptor for A1-F18( )-FRM-000.

b. Corrective action taken for malfunction.

c. Logic used to isolate malfunction.

d. Probable changes that could shorten troubleshooting time for malfunction.

31. **DIAGRAMS.**

32. System schematics are in A1-F18A( )-( )-500 series manuals.

33. **ILLUSTRATED PARTS BREAKDOWN.**

34. Each illustrated parts breakdown (IPB) in this manual has a parts list and illustration for the requisition, storage, authority for use and identification of parts. The illustration is integrated with, and supports, both the maintenance procedure and the parts list within each work package.

35. **PART NUMBER COLUMN.** Footnote symbols in the part number column are defined following the last part listed in each parts list (also see converted part numbers, this WP).

36. **INDENTION.** The first entry in the description column of each parts list is the figure title. This figure title identifies the parts list with the related

Figure B1.0-20 A1-F18AC-450-200 2-00p5

28. **TROUBLESHOOTING BEYOND BIT/ SYSTEM TESTING.** This is required when any of the conditions listed below exist:

a. Malfunction was not detected by Built-In Test (BIT).

b. Malfunction was not detected by a functional test procedure.

c. When a troubleshooting procedure did not correct the malfunction.

d. When a troubleshooting procedure does not exist.

29. When any of the conditions listed in paragraph 28 exist, troubleshooting procedure/logic must then be determined. Use steps listed below to aid in determining procedure/logic:

a. Use referenced system schematic or select applicable system schematic for malfunction. Use schematic for troubleshooting beyond BIT analysis as listed below:

(1) Analyze interface of system components. Determine logic wiring and/or components which may cause the malfunction. Determine when an interfacing component could cause the malfunction.

(2) When malfunction can be caused by mission computer system signal interface, do applicable steps below:

(a) Analyze mission computer system integrated functions. Use REF CODES on system schematics for aid when interpreting computer software logic (A1-F18A( )-OLD-( ) series manuals).

(b) Memory inspect suspected Input/Output REF CODES (A1-F18AC-FIM-100).

b. Review VIDS/MAF (OPNAV 4790/60) in Aircraft Discrepancy Book for related malfunctions.

(1) Analyze system/related system maintenance codes reported by Nose Wheelwell Digital Display Indicator.

(2) Determine if aircraft components that have been replaced could cause malfunction.

(3) When a repeat malfunction exists, analyze previous maintenance action completed for the malfunction.

(a) When component replacement is/was done, analyze component history as listed:

1) Determine where component came from.

2) Determine previous history of component (when available).

3) Determine if similar malfunction occurred on another aircraft.

4) Determine if replaced component could be causing existing malfunction.

5) Determine if replacing component again would correct malfunction.

(b) Determine if any rigging or control procedures that have been done could cause the malfunction.

(c) Determine when rigging/boresight procedures should be done to verify system operation for malfunction.

30. **TROUBLESHOOTING IMPROVEMENTS.** When a troubleshooting procedure did not correct a malfunction and it is determined that additional or new troubleshooting is required, submit Technical Publications Deficiency Report (TPDR) providing the information listed below:

a. Fault descriptor for A1-F18( )-FRM-000.

b. Corrective action taken for malfunction.

c. Logic used to isolate malfunction.

d. Probable changes that could shorten troubleshooting time for malfunction.

31. DIAGRAMS.

32. System schematics are in A1-F18A( )-( )-500 series manuals.

33. ILLUSTRATED PARTS BREAKDOWN.

34. Each illustrated parts breakdown (IPB) in this manual has a parts list and illustration for the requisition, storage, authority for use and identification of parts. The illustration is integrated with, and supports, both the maintenance procedure and the parts list within each work package.

Figure B1.0-21 A1-F18AC-510-200 2-00p5

maintenance procedure and is shown in the first indent. All parts data required to support the specific maintenance procedure is below the figure title in the second indent.

37. **COMMON NAMES.** The official nomenclature in the description column may not be the name commonly used for an item. If different from the official nomenclature, the common name is shown in parentheses in the description column immediately following the official nomenclature.

38. **COMMERCIAL AND GOVERNMENT ENTITY CODES.** Entity code or manufacturer's name and address are shown in the Description column in parentheses after the nomenclature for the item. These codes are per the Commercial and Government Entity (CAGE) Handbook H4/H8 Series. No code indicates the item is a government standard part.

39. **ATTACHING PARTS.** Attaching parts are identified by (AP) after the nomenclature of the item in the description column. Attaching parts are listed immediately following the part they attach.

40. **SPECIAL HANDLING.** Items requiring special handling such as liquid oxygen components, magnetic control items or on-board oxygen generating system (OBOGS) are identified by the acronym LOX for liquid oxygen, MAG for magnetic control and OXYGEN for on-board oxygen generating system (OBOGS) in the Description column, at the extreme right side.

41. **CONVERTED PART NUMBERS.** Some part numbers appear in the Part Number column which are different than the manufacturer's part number. These are converted part numbers. The unconverted manufacturer's part number is shown in the Description column following the manufacturer's code. Always use the part number in the Part Number column when ordering parts. If an item is not available under the listing in the Part Number column, it may be ordered using the unconverted part number found in the Description column or by using the number found on the part. Examples of special characters as they may appear in the Part Number and Description columns are shown below:

Part Number Column	Description Column
PORM	± (Plus or Minus)
DEG	° (Degree)
E	e (Lower case letter)
2	II (Roman Numeral)
0.001	.001 (Decimal)

42. **SUPERSEDED PARTS.** Superseded part numbers have been removed from the Part Number column and placed in the Description column of the superseding part (for example - supersedes 74A582090-1003). This indicates that the superseded part is usable if available through salvage, but should not be requisitioned or made.

43. **NEXT HIGHER ASSEMBLY.** Next higher assembly (NHA) data is not shown using indention. Next higher procurable assembly (NHPA) data is shown for part numbers that have a procurable NHA. The NHPA and its assigned Source, Maintenance and Recoverability (SM&R) code are in parentheses as the last entry in the Description column. Requisition the NHPA when the part listed in the Part Number column is not available from supply. The components of assemblies that required disassembly during removal from aircraft, are footnoted in the part number column.

44. **UNITS PER ASSEMBLY COLUMN (UPA).** This column lists the total number of each part required per assembly or subassembly and are not necessarily the total number used in the end item of equipment. The letters AR (As Required) are used for items such as shims when the requirement may vary.

45. **USABLE-ON CODES.** Applicable usable-on codes are identified on the final sheet of each parts list. No entry in the Use On column indicates parts are applicable to all configurations supported by this parts list.

46. **ALTERNATE OR EQUIVALENT PARTS.** An asterisk (*), in the Use On column, identifies alternate parts or equivalent parts that are interchangeable. When a letter code is followed by an asterisk in the Use On column, only the parts with the same letter code are interchangeable. An alternate part may be used when preferred part is

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35. **PART NUMBER COLUMN.** Footnote symbols in the part number column are defined following the last part listed in each parts list (also see converted part numbers, this WP).

36. **INDENTION.** The first entry in the description column of each parts list is the figure title. This figure title identifies the parts list with the related maintenance procedure and is shown in the first indent. All parts data required to support the specific maintenance procedure is below the figure title in the second indent.

37. **COMMON NAMES.** The official nomenclature in the description column may not be the name commonly used for an item. If different from the official nomenclature, the common name is shown in parentheses in the description column immediately following the official nomenclature.

38. **COMMERCIAL AND GOVERNMENT ENTITY CODES.** Entity code or manufacturer's name and address are shown in the Description column in parentheses after the nomenclature for the item. These codes are per the Commercial and Government Entity (CAGE) Handbook H4/H8 Series. No code indicates the item is a government standard part.

39. **ATTACHING PARTS.** Attaching parts are identified by (AP) after the nomenclature of the item in the description column. Attaching parts are listed immediately following the part they attach.

40. **SPECIAL HANDLING.** Items requiring special handling such as liquid oxygen components, magnetic control items or on-board oxygen generating system (OBOGS) are identified by the acronym LOX for liquid oxygen, MAG for magnetic control and OXYGEN for on-board oxygen generating system (OBOGS) in the Description column, at the extreme right side.

41. **CONVERTED PART NUMBERS.** Some part numbers appear in the Part Number column which are different than the manufacturer's part number. These are converted part numbers. The unconverted manufacturer's part number is shown in the Description column following the manufacturer's code. Always use the part number in the Part Number column when ordering parts. If an item is not available under the listing in the Part Number column, it may be ordered using the unconverted part number found in the Description column or by using the number found on the part. Examples of special characters as they may appear in the Part Number and Description columns are shown below:

Part Number Column	Description Column
PORM	± (Plus or Minus)
DEG	° (Degree)
E	e (Lower case letter)
2	II (Roman Numeral)
0.001	.001 (Decimal)

42. **SUPERSEDED PARTS.** Superseded part numbers have been removed from the Part Number column and placed in the Description column of the superseding part (for example - supersedes 74A582090-1003). This indicates that the superseded part is usable if available through salvage, but should not be requisitioned or made.

43. **NEXT HIGHER ASSEMBLY.** Next higher assembly (NHA) data is not shown using indention. Next higher procurable assembly (NHPA) data is shown for part numbers that have a procurable NHA. The NHPA and its assigned Source, Maintenance and Recoverability (SM&R) code are in parentheses as the last entry in the Description column. Requisition the NHPA when the part listed in the Part Number column is not available from supply. The components of assemblies that required disassembly during removal from aircraft, are footnoted in the part number column.

44. **UNITS PER ASSEMBLY COLUMN (UPA).** This column lists the total number of each part required per assembly or subassembly and are not necessarily the total number used in the end item of equipment. The letters AR (As Required) are used for items such as shims when the requirement may vary.

45. **USABLE-ON CODES.** Applicable usable-on codes are identified on the final sheet of each parts list. No entry in the Use On column indicates parts are applicable to all configurations supported by this parts list.

46. **ALTERNATE OR EQUIVALENT PARTS.** An asterisk (*), in the Use On column, identifies

Figure B1.0-23 A1-F18AC-510-200 2-00p6

SOURCE			
1st POSITION		**2nd POSITION**	
P	PROCURE	A	STOCKED
		B	INSURANCE BUY
		C	CURE-DATED ITEM
		D	INITIAL OUTFITTING
		E	GSE/STOCKED
		F	GSE/NOT STOCKED
		G	SUSTAINED SUPPORT
K	REPAIR KIT COMPONENT	D	DEPOT
		F	ORGANIZATIONAL/IMA
		B	BOTH KITS
M	MANUFACTURE	O	ORGANIZATIONAL
		F	INTERMEDIATE AFLOAT
A	ASSEMBLE	H	INTERMEDIATE ASHORE
		G	INTERMEDIATE AFLOAT/ASHORE
		D	DEPOT
X	MISCELLANEOUS	A	USE NEXT HIGHER ASSEMBLY
		B	OBTAIN FROM SALVAGE OR ONE TIME BUY
		C	DIAGRAM-SCHEMATICS, INSTALLATION DRAWINGS

MAINTENANCE			
REMOVE/REPLACE		**REPAIR**	
3rd POSITION		**4th POSITION**	
O	REPLACE OR USE AT ORGANIZATIONAL LEVEL	Z	NO REPAIR (CONSUMABLE)
	REPLACE OR USE AT IMA LEVEL	B	RECONDITION BY ADJUSTMENT, CALIBRATION, LUBRICATION, PLATING, ETC.
F	INTERMEDIATE AFLOAT		
H	INTERMEDIATE ASHORE		
G	INTERMEDIATE AFLOAT/ ASHORE		
D	REPLACE OR USE AT DEPOT	O	REPAIR AT ORGANIZATIONAL LEVEL
			REPAIR AT IMA LEVEL
		F	INTERMEDIATE AFLOAT
		H	INTERMEDIATE ASHORE
		G	INTERMEDIATE AFLOAT/ ASHORE
L	SPECIALIZED IMA REPAIR SITE	D	REPAIR AT DEPOT OR COMMERCIAL
Z	NOT AUTHORIZED TO BE REMOVED OR REPLACED	L	REPAIR AT SPECIALIZED IMA SITE

RECOVERABILITY	
5th POSITION	
Z	NON-REPAIRABLE ITEM. CONDEMN AND DISPOSE AT LEVEL INDICATED IN 3rd POSITION.
O	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT ORGANIZATIONAL LEVEL.
	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT IMA LEVEL INDICATED
F	INTERMEDIATE AFLOAT
H	INTERMEDIATE ASHORE
G	INTERMEDIATE AFLOAT/ASHORE
D	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT DEPOT OR CONTRACTOR FACILITY.
L	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT SPECIALIZED IMA REPAIR SITE.
A	SPECIAL HANDLING REQUIRED. CONTACT ITEM MANAGER FOR DISPOSAL INSTRUCTIONS.

SERVICE OPTION	
6th POSITION	
1 2 3	APPLIES TO ENGINES ONLY. IDENTIFIES THE HIGHEST (1) TO LOWEST (3) LEVEL OF MAINTENANCE WHICH CAN REPLACE (3rd POSITION OF SMR CODE) THE ITEM.
6	NORMALLY PROCURED COMMERCIAL BUT ORGANIC CAPABILITY EXISTS AT NARF FOR EMERGENCY STOP GAP REQUIREMENTS.
E	"I" LEVEL REPAIR NOT AUTHORIZED BUT "I" LEVEL MUST VALIDATE FAILURE PRIOR TO BCM TO DEPOT.
J	DESIGNATES INTER-SERVICE DLR, PER NAVY MP CONSIDERED COMPLETELY REPAIRABLE BELOW DEPOT LEVEL.
8	SAME AS "J" ABOVE EXCEPT USED FOR ENGINES ONLY. APPLIES TO 2nd DEGREE ENG. MAINTENANCE LEVEL.
9	SAME AS "J" ABOVE EXCEPT USED FOR ENGINES ONLY. APPLIES TO 3rd DEGREE ENG. MAINTENANCE LEVEL.
P	DENOTES ITEMS WHICH ARE PROGRESSIVELY REPAIRED AT ORG, INT, AND DEPOT LEVELS. BLANK IF NO INT. REPAIR IS AUTHORIZED BETWEEN O & D LEVEL.
N	ASSIGNED TO XB SOURCE CODE AND INDICATES ITEM IS PROCURED LOCALLY, NOT STOCKED IN THE SUPPLY SYSTEM.
T	ASSIGNED TO TRAINING DEVICES WITH SOURCE CODE OF "PD." INDICATES ITEM IS NOT A PROCURABLE SPARE. WSN IS ASSIGNED ONLY TO PERMIT VISIBILITY OF REPAIR PART RELATIONSHIP.

Figure 1. SM&R Code Explanation

Figure B1.0-24 A1-F18AC-450-200 2-00p8

SOURCE			
1st POSITION		2nd POSITION	
P	PROCURE	A	STOCKED
		B	INSURANCE BUY
		C	CURE-DATED ITEM
		D	INITIAL OUTFITTING
		E	GSE/STOCKED
		F	GSE/NOT STOCKED
		G	SUSTAINED SUPPORT
K	REPAIR KIT COMPONENT	D	DEPOT
		F	ORGANIZATIONAL/IMA
		B	BOTH KITS
M	MANUFACTURE	O	ORGANIZATIONAL
		F	INTERMEDIATE AFLOAT
		H	INTERMEDIATE ASHORE
A	ASSEMBLE	G	INTERMEDIATE AFLOAT/ASHORE
		D	DEPOT
X	MISCELLANEOUS	A	USE NEXT HIGHER ASSEMBLY
		B	OBTAIN FROM SALVAGE OR ONE TIME BUY
		C	DIAGRAM-SCHEMATICS, INSTALLATION DRAWINGS

MAINTENANCE			
REMOVE/ REPLACE		REPAIR	
3rd POSITION		4th POSITION	
O	REPLACE OR USE AT ORGANIZATIONAL LEVEL	Z	NO REPAIR (CONSUMABLE)
	REPLACE OR USE AT IMA LEVEL	B	RECONDITION BY ADJUSTMENT, CALIBRATION, LUBRICATION, PLATING, ETC
F	INTERMEDIATE AFLOAT		
H	INTERMEDIATE ASHORE		
G	INTERMEDIATE AFLOAT/ ASHORE		
D	REPLACE OR USE AT DEPOT	O	REPAIR AT ORGANIZATIONAL LEVEL
			REPAIR AT IMA LEVEL
		F	INTERMEDIATE AFLOAT
		H	INTERMEDIATE ASHORE
		G	INTERMEDIATE AFLOAT/ ASHORE
L	SPECIALIZED IMA REPAIR SITE	D	REPAIR AT DEPOT OR COMMERCIAL
Z	NOT AUTHORIZED TO BE REMOVED OR REPLACED	L	REPAIR AT SPECIALIZED IMA SITE

RECOVERABILITY		SERVICE OPTION	
5th POSITION		6th POSITION	
Z	NON-REPAIRABLE ITEM. CONDEMN AND DISPOSE AT LEVEL INDICATED IN 3rd POSITION.	1 2 3	APPLIES TO ENGINES ONLY. IDENTIFIES THE HIGHEST (1) TO LOWEST (3) LEVEL OF MAINTENANCE WHICH CAN REPLACE (3rd POSITION OF SMR CODE) THE ITEM.
O	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT ORGANIZATIONAL LEVEL.	6	NORMALLY PROCURED COMMERCIAL BUT ORGANIC CAPABILITY EXISTS AT NARF FOR EMERGENCY STOP GAP REQUIREMENTS.
	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT IMA LEVEL INDICATED	E	"I" LEVEL REPAIR NOT AUTHORIZED BUT "I" LEVEL MUST VALIDATE FAILURE PRIOR TO BCM TO DEPOT.
F	INTERMEDIATE AFLOAT	J	DESIGNATES INTER-SERVICE DLR, PER NAVY MP CONSIDERED COMPLETELY REPAIRABLE BELOW DEPOT LEVEL.
H	INTERMEDIATE ASHORE		
G	INTERMEDIATE AFLOAT/ASHORE	8	SAME AS "J" ABOVE EXCEPT USED FOR ENGINES ONLY. APPLIES TO 2nd DEGREE ENG. MAINTENANCE LEVEL.
D	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT DEPOT OR CONTRACTOR FACILITY.	9	SAME AS "J" ABOVE EXCEPT USED FOR ENGINES ONLY. APPLIES TO 3rd DEGREE ENG. MAINTENANCE LEVEL.
L	REPAIRABLE ITEM. CONDEMN AND DISPOSE AT SPECIALIZED IMA REPAIR SITE.	P	DENOTES ITEMS WHICH ARE PROGRESSIVELY REPAIRED AT ORG, INT, AND DEPOT LEVELS. BLANK IF NO INT. REPAIR IS AUTHORIZED BETWEEN O & D LEVEL.
		N	ASSIGNED TO XB SOURCE CODE AND INDICATES ITEM IS PROCURED LOCALLY. NOT STOCKED IN THE SUPPLY SYSTEM.
A	SPECIAL HANDLING REQUIRED. CONTACT ITEM MANAGER FOR DISPOSAL INSTRUCTIONS.	T	ASSIGNED TO TRAINING DEVICES WITH SOURCE CODE OF "PD." INDICATES ITEM IS NOT A PROCURABLE SPARE. WSN IS ASSIGNED ONLY TO PERMIT VISIBILITY OF REPAIR PART RELATIONSHIP.

Figure 1. SM&R Code Explanation

Figure B1.0-25 A1-F18AC-510-200 2-00p8

Table 1. Functional Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
	3. As reservoir continues to fill, circuit 1A indicator(s) retract and HYD 1A display disappears from DDI.	1. If circuit 1A indicator(s) do not retract, replace reservoir (A1-F18AC-450-300, WP005 00). 2. If the HYD 1A display does not disappear, replace the circuit 1A pressure switch 10S-P006A (A1-F18AC-450-300, WP005 00).

CAUTION

To prevent damage to hydraulic reservoir, during overfill operation, do not exceed 140 PSI. If reservoir overboard relief does not occur before or at 140 PSI, stop reservoir overfilling operation.

Procedure	Normal Indication	Remedy for Abnormal Indication
(3) Continue to fill reservoir until reservoir fluid level indicator indicates reservoir is overfull (needle white area).	As reservoir overfills, reservoir overflow valve opens and hydraulic fluid begins to flow from reservoir overboard vent.	If hydraulic fluid does not flow from reservoir overboard vent when reservoir is overfilled, replace reservoir (A1-F18AC-450-300, WP005 00).
(4) Stop filling reservoir.	As hydraulic fluid supply is shutoff, reservoir overflow valve closes and hydraulic fluid flow from reservoir overboard vent stops.	If hydraulic fluid continues to flow from reservoir overboard vent, replace reservoir (A1-F18AC-450-300, WP005 00).
(5) Bleed off excess fluid, by operating reservoir bleed valve, until reservoir fluid level indicator indicates FULL (needle in green area).		
j. Turn off external hydraulic power from hydraulic system 1 (A1-F18AC-LMM-000).		
k. Remove hydraulic servicing unit hand pump from hydraulic system 1 (A1-F18AC-PCM-000).		
l. Remove hydraulic components airbleed assembly from hydraulic system 1 reservoir air bleed valve.		

Figure B1.0-26 A1-F18AC-450-200 3-00p15

Table 2. Operational Test for Fault Isolation (Continued)

Step	Procedure	Normal Indication	Maintenance Action
	c. FOCS up arrow and hold down.	Number next to FOCS label increases. FLIR focus changes.	Check FLIR BIT display WP004 00, 005 00, or 006 00.
	d. FOCS down arrow and hold down.	Number next to FOCS label decreases. FLIR focus changes.	Check FLIR BIT display WP004 00, 005 00, or 006 00.
	e. If ALG is boxed, unbox.	LVL and GN label is displayed (figure 2).	Check FLIR BIT display WP004 00, 005 00, or 006 00.
	f. LVL up arrow and hold down.	Number next to LVL label increases. FLIR video level changes.	Check FLIR BIT display WP004 00, 005 00, or 006 00.
	g. LVL down arrow and hold down.	Number next to LVL label decreases. FLIR video level changes.	Check FLIR BIT display WP004 00, 005 00, or 006 00.

Figure B1.0-27 A1-F18AC-744-210 3-00p17

TABLE 5. LEFT CLA INPUT/OUTPUT SIGNALS (CONT)

Designation	Function
13M	BB Door - Emergency Open
14M	BB Door - Emergency Close
17M	Ground Service Access Door - Closed
35Y	Electric Motor - BB Door Close Time Delay (Set) 28FF + 14M • $\overline{1M}$ • $\overline{3M}$ (Reset) 2 seconds after signal goes false
37Y	Electric Motor Safety Relay - BB Door Close (Set) 30FF + 14M • $\overline{1M}$ • $\overline{3M}$ (Reset) 2 seconds after signal goes false
40Y	Pulse each time 1M + 3M + 5M goes true
4MO	BB Door Open-Elect (K304 Relay)
5MO	BB Door Close-Elect (K302 Relay)
6MO	BB Door Safety Relay (K300 Relay)
7MO	BB Door Closed Signal

TABLE 6. RIGHT CLA INPUTS/OUTPUTS

Designation	Function
2G	Landing Gear Handle-UP
1M	BB Door Closed-LH
3M	BB Door Closed-RH
8M	BB Door Open to Stores-drop Position (RH)
11M	BB Door Control Signal - Both Open and Close (11M Reset by 7MO or 8MO)
12M	Common
13M	BB Door - Emergency Open
14M	BB Door - Emergency Close
17M	Ground Service Access Door - Closed

Figure B1.0-28 NAVAIR 01-S3AAA-2-3.2 3-00p18

Table 1. Functional Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
(2) Operate reservoir bleed valve, in right main landing gear wheelwell, to bleed air from reservoir, until reservoir fluid level indicator indicates reservoir is FULL (needle in green area).	1. As reservoir starts to fill, circuit 2B shutoff valve indicator extends and HYD 2B display appears on DDI.	1. If shutoff valve indicator does not extend, replace the reservoir (A1-F18AC-450-300, WP005 00).
		2. If the HYD 2B display does not appear, do Table 6.
	2. As reservoir continues to fill, circuit 2B shutoff valve indicator retracts, circuit 2A shutoff valve indicator extends, HYD 2B display disappears and HYD 2A display appears on DDI.	1. If circuit 2B shutoff valve indicator remain extended and/or circuit 2A shutoff valve indicator remains retracted, replace reservoir (A1-F18AC-450-300, WP005 00).
		2. If circuit 2B display does not disappear, replace circuit 2B pressure switch 10S-R007B (A1-F18AC-450-300, WP005 00).
		3. If circuit 2A display does not appear, do Table 7.
	3. As reservoir continues to fills, circuit 2A shutoff valve indicator retracts and HYD 2A display disappears from DDI.	1. If circuit 2A shutoff valve indicator does not retract, replace reservoir (A1-F18AC-450-300, WP005 00).
		2. If HYD 2A display does not disappear, replace circuit 2A pressure switch 10S-R007A (A1-F18AC-450-300, WP005 00).

CAUTION

To prevent damage to hydraulic reservoir, during overfill operation, do not exceed 140 PSI. If reservoir overboard relief does not occur before or at 140 PSI, stop reservoir overfilling operation.

(3) Continue to fill reservoir until reservoir fluid level indicator indicates reservoir is overfull (needle in white area).	As reservoir overfills, reservoir overflow valve opens and hydraulic fluid begins to flow from reservoir overboard vent.	If hydraulic fluid does not flow from reservoir overboard vent when reservoir is overfilled, replace reservoir (A1-F18AC-450-300, WP005 00).

Figure B1.0-29 A1-F18AC-450-200 3-00p18

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003 00

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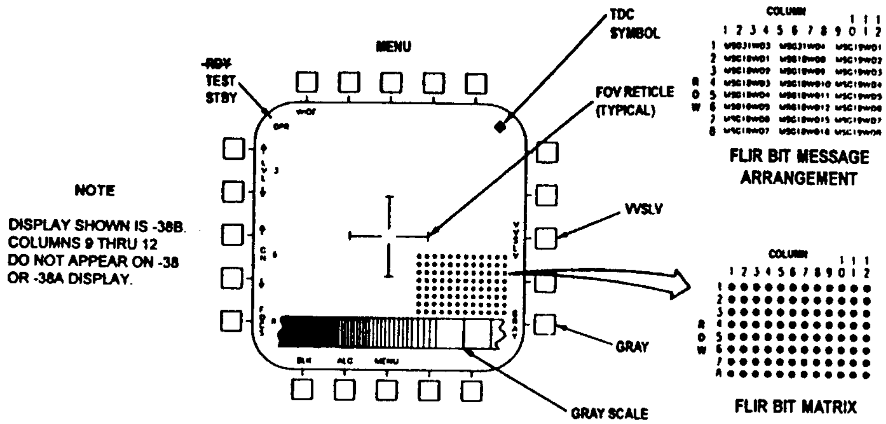

Figure 2. FLIR Control Display

Figure B1.0-30 A1-F18AC-744-210 3-00p21

A1-F18AC-744-210

003 00

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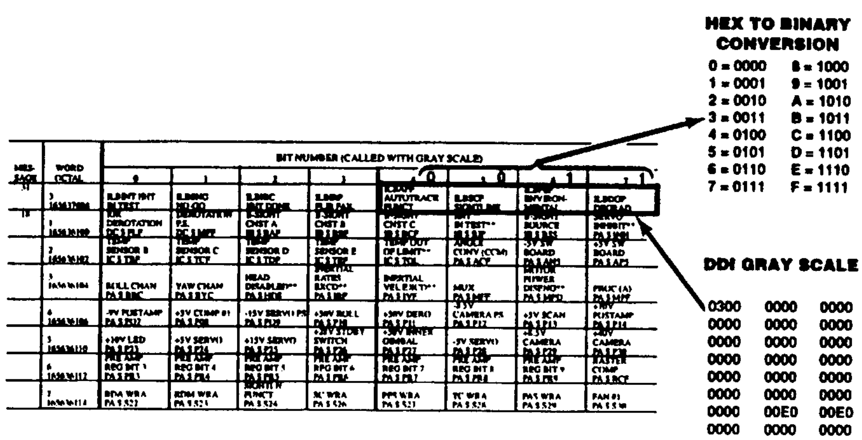

Figure 4. Gray Scale Interpretation

Figure B1.0-31 A1-F18AC-744-210 3-00p23

TABLE 10. BOMB BAY DOORS DO NOT STOP AT STORES-DROP POSITION WHEN OPERATED FROM ACP TROUBLESHOOTING PROCEDURE (CONT)

Question	Action for Yes	Action for No
After doors are closed, close bomb bay ground service access door 1223-1. (If ground service access door is not securely closed, flight station control is inoperable). At flight station, open bomb bay doors using DOORS pushbutton, and observe switchlight from TRANS to OPEN. Do bomb bay doors stop when OPEN light comes on?	1b Check SP8 proximity switch for proper adjustment (NAVAIR 01-S3AAA-2-4.2 SWP 004 08). If SP8 proximity switch is adjusted, verify switch output signal and perform check of right CLA (NAVAIR 01-S3AAA-2-3.11 WP 009 00). If SP8 proximity switch is not adjusted, adjust switch (NAVAIR 01-S3AAA-2-4.2 SWP 004 08).	1c Check SP5 proximity switch for proper adjustment (NAVAIR 01-S3AAA-2-4.2 SWP 004 08). If SP5 proximity switch is adjusted, verify switch output signal and perform check of left CLA (NAVAIR 01-S3AAA-2-3.11 WP 008 00). If SP5 proximity switch is not adjusted, adjust switch (NAVAIR 01-S3AAA-2-4.2 SWP 004 08).

TABLE 11. DOORS OPEN TO STORES-DROP POSITION BUT ACP LIGHT FAILS TO INDICATE OPEN TROUBLESHOOTING PROCEDURE

Question	Action for Yes	Action for No
1a Disconnect P645 plug connector from ARMAMENT CONTROL panel (ACP) (NAVAIR 01-S3AAA-2-4.13 WP 010 00). Ensure CURRENT LMTRS FLT STA 1 and CURRENT LIMITER FLT STA 11 circuit breakers are closed. Check for 28 Vdc between P645 plug connector pins 82 and 4. 28 Vdc?	1b Replace ACP (NAVAIR 01-S3AAA-2-4.13 WP 010 00).	1c Open and tag circuit breakers listed in table 3. Open ground service access door 1223-1 and install BD31-103 Bomb Bay Door Safety Pin. Disconnect P423 plug connector at floor level in right bomb bay. Ensure CURRENT LMTRS L LOAD CTR 1 and CURRENT LMTRS L LOAD CTR 11 are closed.

Figure B1.0-32 NAVAIR 01-S3AAA-2-3.2 3-00p26

A1-F18AC-744-210

003 00

Page 27/(28 blank)

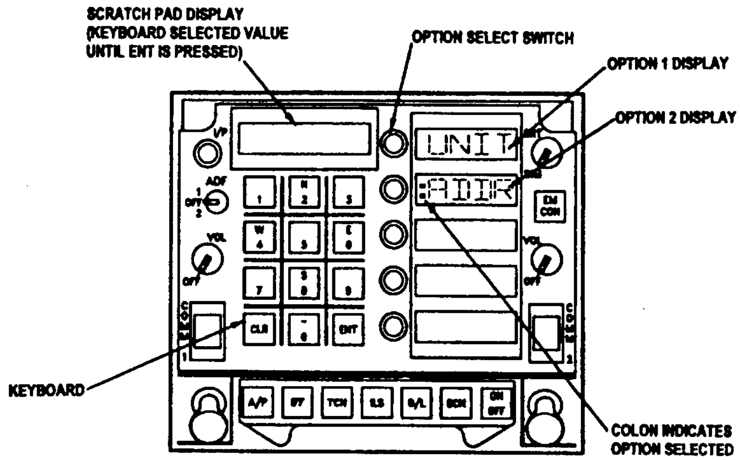

Figure 6. Electronic Equipment Control

Figure B1.0-33 A1-F18AC-744-210 3-00p27

TABLE 1. WEAPON REPLACEABLE ASSEMBLIES

Nomenclature	Location	Common Name	Qty
	Bomb Bay Door System		
Outboard Bomb Bay Door Assembly	Outboard bottom fuselage forward of MLG	Outboard door	2
Inboard Bomb Bay Door Assembly	Center bottom fuselage forward of main landing gear (MLG)	Inboard door	2
Stop Bolt	Inboard bomb bay door edge	Door stop (bolt)	4
Door Linkage Bellcrank	Internal bomb bay, forward and aft bulkhead area	Bellcrank	4
Connecting Link	Internal bomb bay	Connecting link	12
Door Drive System Geared Hinge	Outboard bomb bay door hinge	Geared hinge	8
Door Drive System Torque Tube Sections	Outboard doors	Torque tube	8
Door Drive System Tee Drive	Internal bomb bay, forward outboard door hinge area	T-drive	2
Door Drive System Rotary Flex Shaft	Internal bomb bay, forward area	Flex shaft	2
Door Drive System Angle Drive	Internal bomb bay, forward inboard door hinge area	Angle drive	2
Power Drive Unit	Bottom fuselage between bomb bay doors	Power drive unit (PDU)	1
Torque Limiter Actuator	Inboard of angle drives	Torque limiter actuator	2
Torque Tube	Between PDU and angle drive	Torque tube	1
Manual Drive System Torque Limiter and Locking Plate	Ground control panel	Manual drive fitting	1
Manual Drive System Torque Tube	Between manual drive fitting and angle drive	Torque tube	1
Manual Drive System Angle Drive	Between torque tube and manual drive flex shaft	Angle drive	1
Manual Drive System Rotary Flex Shaft	Between angle drive and manual drive input fitting on PDU	Manual drive flex shaft	1

Figure B1.0-34 NAVAIR 01-S3AAA-2-3.2 3-00p3

Table 2. Operational Test for Fault Isolation (Continued)

Step	*Procedure*	*Normal Indication*	*Maintenance Action*
1	Apply electrical power to aircraft (A1-F18AC-LMM-000).		
2	On GND PWR control panel assembly, set and hold 1, 2, and 3 switches to B ON for three seconds.	Switches remain on (latched).	Troubleshoot switches (A1-F18AC-FIM-000, WP012 00).
3	On left and right digital display indicators (LDDI and RDDI), set power switch to DAY or NIGHT and allow 2-minute warm-up. Adjust BRT and CONT controls for best display.	LDDI and RDDI have display and center pushbutton switch on bottom row is labeled MENU (figure 1).	a. No LDDI display, but RDDI display, troubleshoot bad LDDI. b. No RDDI display, but LDDI display, troubleshoot bad RDDI.
4	On LDDI, press and release MENU pushbuttons switch until BIT pushbutton switch option appears.	LDDI has BIT pushbutton switch option (figure 1).	Check aircraft/manual effectivity and perform Displays Test (A1-F18AC-745-200 or A1-F18AG-745-200, WP004 00 or 005 00).

Figure B1.0-35 A1-F18AC-744-210 3-00p4

Table 6. Hydraulic System 2B Display Does Not Appear On DDI (Continued)

Procedure	No	Yes
NOTE The question used in logic tree "Does continuity exist" means to test for the items listed below: 1. Pin to pin test per procedural step. 2. Shorts to ground. 3. Shorts between surrounding pins on connectors. 4. Shorts between shield and conductors. 5. Shield continuity.		
a. Do substeps listed below:		
(1) Turn off external hydraulic power (A1-F18AC-LMM-000).		
(2) Does HYD 2B display appear on DDI?	c	b
b. Replace the hydraulic reservoir (A1-F18AC-450-300, WP005 00).		
c. Do substeps below:		
(1) Disconnect connector 10P-R007B from Reservoir (HS 2) circuit B pressure switch.		
(2) Does continuity exist between pins A and B of Reservoir (HS 2) circuit B pressure switch 10S-R007B?	e	d
d. Replace hydraulic system 2B circuit pressure switch (A1-F18AC-450-300, WP005 00).		
e. Do substeps below:		
(1) Open doors 13L and 14R (A1-F18AC-LMM-010).		
(2) Disconnect connectors listed below: 83P-E001C from Digital Data Computer No. 1 83P-F002C from Digital Data Computer No. 2		
(3) Does continuity exist from: 10P-R007B pin A to 83P-E001C pin 79 10P-R007B pin B to 83P-E001C pin 78 10P-R007B pin A to 83P-F002C pin 79 10P-R007B pin B to 83P-F002C pin 78?	f	g
f. Isolate and repair defective aircraft wiring between connector 10P-R007B and connectors 83P-E001C/83P-F002C (A1-F18A( )-WDM-000) and do step g.		

Figure B1.0-363 A1-F18AC-450-200 3-00p49

Table 8. Hydraulic System Fluid Transfer (Continued)

Procedure	No	Yes
(3) Does hydraulic system 1 reservoir fluid transfer to hydraulic system 2 reservoir occur?	h	e
e. Do substeps below:		

WARNING

Hydraulic fluid is toxic to skin, eyes, and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation is normally enough.

(1) Using a suitable container, in left MLG wheelwell, open fluid sampling valve or reservoir bleed valve, and drain fluid from hydraulic system 1 reservoir until hydraulic system 1A caution appears on DDI.		

NOTE

Cycle grip assembly slowly, so that flight control surfaces go full travel.

(2) Slowly cycle grip assembly in a square pattern, stop to stop, a minumum of 20 times.		
(3) Does hydraulic system 1 reservoir fluid transfer to hydraulic system 2 reservoir occur?	f	g
f. Left rudder switching valve:		
(1) Shut down left engine or turn off external hydraulic power to hydraulic system 1, as applicable (A1-F18AC-LMM-000).		
(2) Remove door 67L (A1-F18AC-LMM-010).		

WARNING

Hydraulic fluid is toxic to skin, eyes, and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation is normally enough.

(3) Disconnect hydraulic system 2B tube assembly from switching valve return (RET 1) port (A1-F18AC-570-300, WP027 00).		
(4) Install machine plug (AE16308-08) on tube assembly.		

Figure B1.0-37 A1-F18AC-450-200 3-00p57

TABLE 2. LIST OF TROUBLESHOOTING PROCEDURES (CONT)

Title	Table No.
Bomb Bay Doors Open But Do Not Close from APC in Electrical Mode Only (Hydraulic Operation Normal) Troubleshooting Procedure	18

4. Wiring data for the bomb bay door system is provided in figure 2 and NAVAIR 01-S3AAA-2-5.1 SWP 003 01.

5. TESTING AND TROUBLESHOOTING.

Support Equipment Required

Part Number	Nomenclature
AHT-63	Electric Drive Portable Hydraulic Test Stand (Carrier)
AHT-64	Diesel Drive Portable Hydraulic Test Stand (Land)
BC62-101	Rigging Pin Kit
BD01-105	CLA Test Set
BD31-103	Bomb Bay Door Ground Control Safety Pin
BD41-101	K1 Test Switch
NC-2A	Mobile Electric Powerplant (Carrier)
NC-8A	Mobile Electric Powerplant (Land)
NR-5C	Air Conditioner (Carrier)
NR-10	Air Conditioner (Land)
1307421-101	Bomb Bay Intercept Cable Assembly

6. PRETEST SETUP.

WARNING

Before turning on electrical power and hydraulic power, ensure that all electrical panels are closed and personnel are clear of flight controls and have been alerted that electrical power and hydraulic power will be turned on.

CAUTION

When electrical power is to be applied, the need to turn on air conditioning depends upon ambient temperature criterion stated in NAVAIR 01-S3AAA-2-1 SWP 007 12.

NOTE

To extend life of equipment, open all color coded circuit breakers, other than those required for specific maintenance procedures, before applying electrical power.

a. Connect and turn on NC-2A or NC-8A Mobile Electric Powerplant (NAVAIR 01-S3AAA-2-1 SWP 007 10), as applicable, and NR-5C or NR-10 Air Conditioner (NAVAIR 01-S3AAA-2-1 SWP 007 12), as applicable.

b. Connect and turn on AHT-63 Electric Drive Portable Hydraulic Test Stand or AHT-64 Diesel Drive Portable Hydraulic Test Stand (NAVAIR 01-S3AAA-2-1 SWP 007 11), as applicable.

c. Ensure that circuit breakers listed in table 3 are closed.

7. FUNCTIONAL CHECKOUT.

a. Ensure that SWITCH LIGHTS control on LIGHT CONTROL panel on center console is set to BRT.

Figure B1.0-38 NAVAIR 01-S3AAA-2-3.2 3-00p6

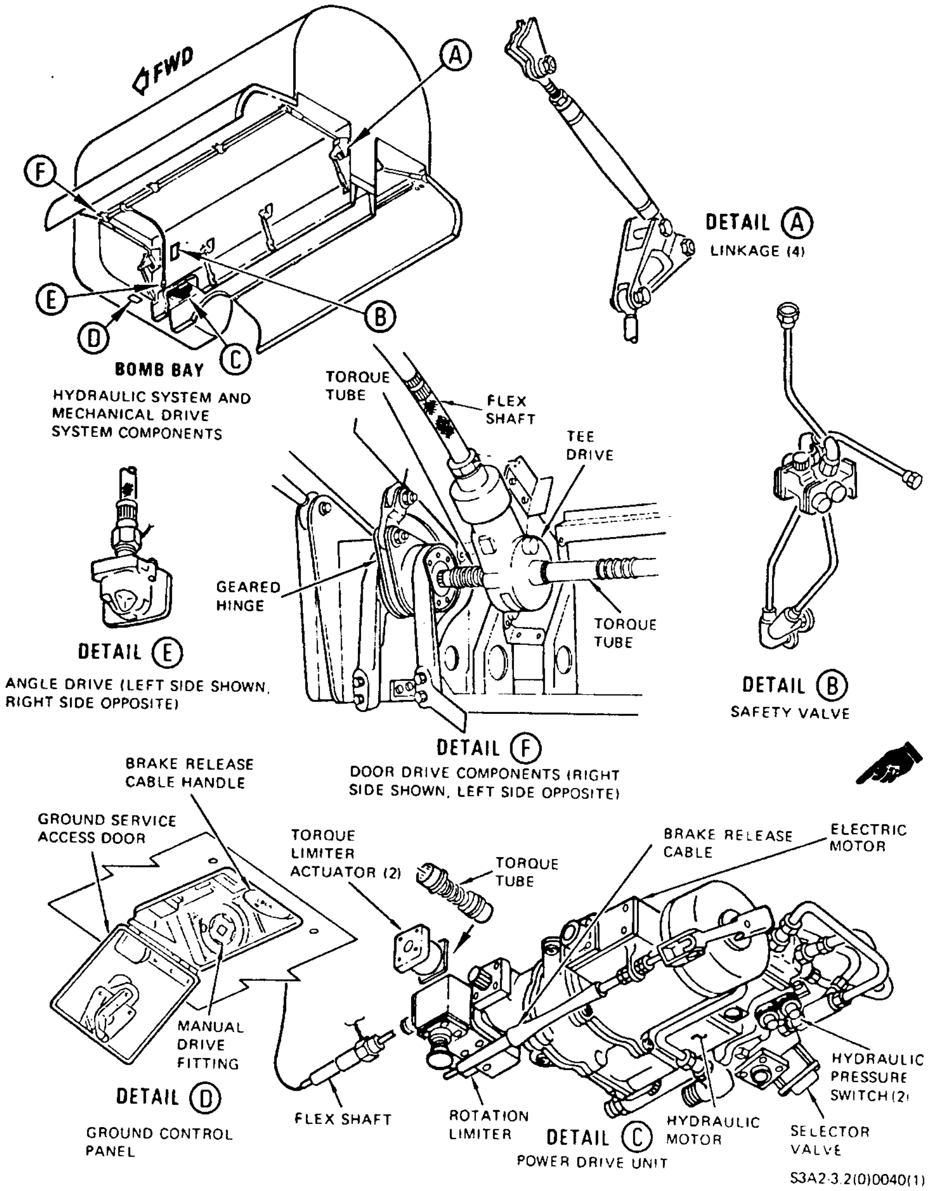

Figure 1. Bomb Bay Door Drive System Controls and Components (Sheet 1 of 3)

Figure B1.0-39 NAVAIR 01-S3AAA-2-3.2 3-00p7

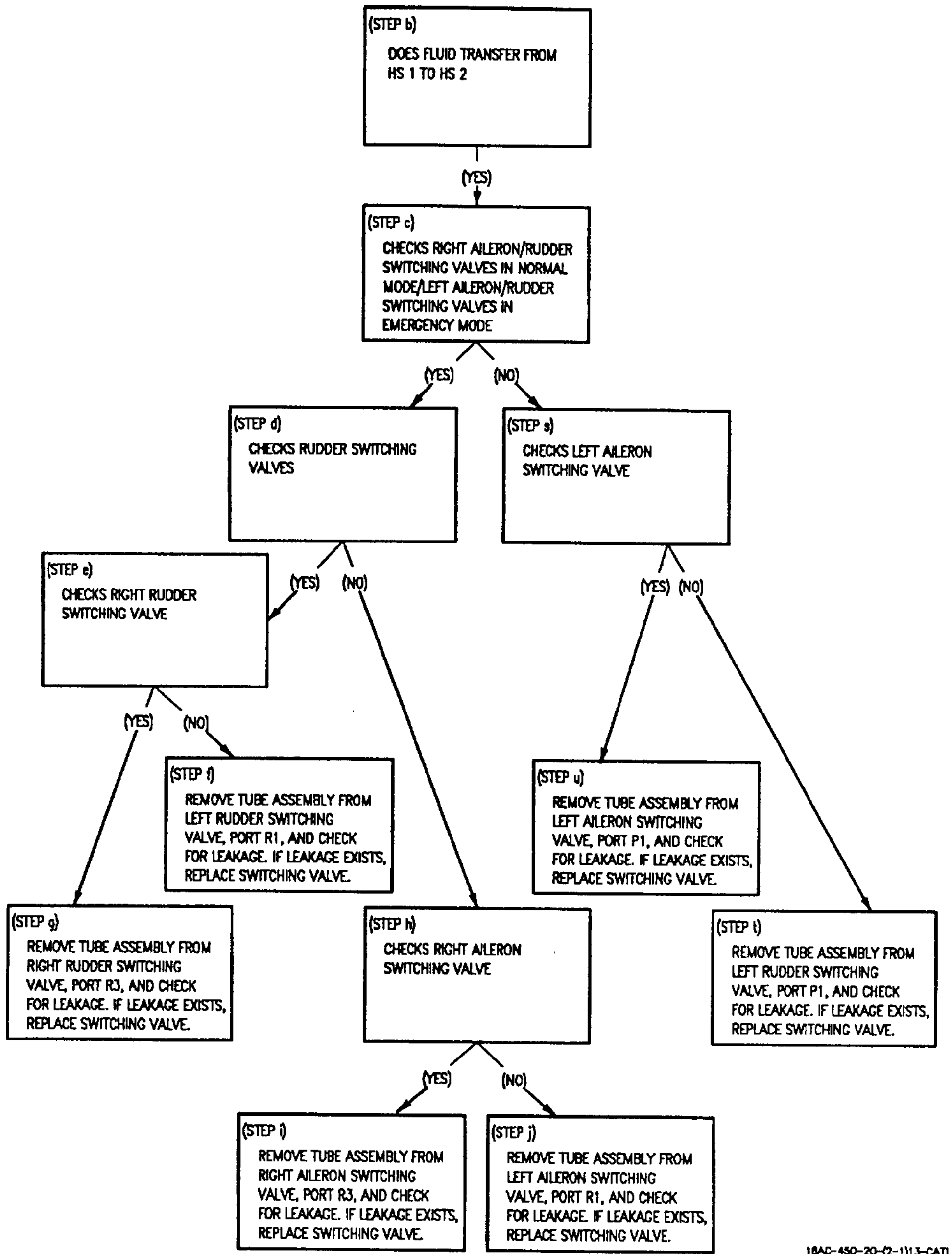

Figure 1. Hydraulic System Fluid Migration (Sheet 1)

Figure B1.0-40 A1-F18AC-450-200 3-00p77

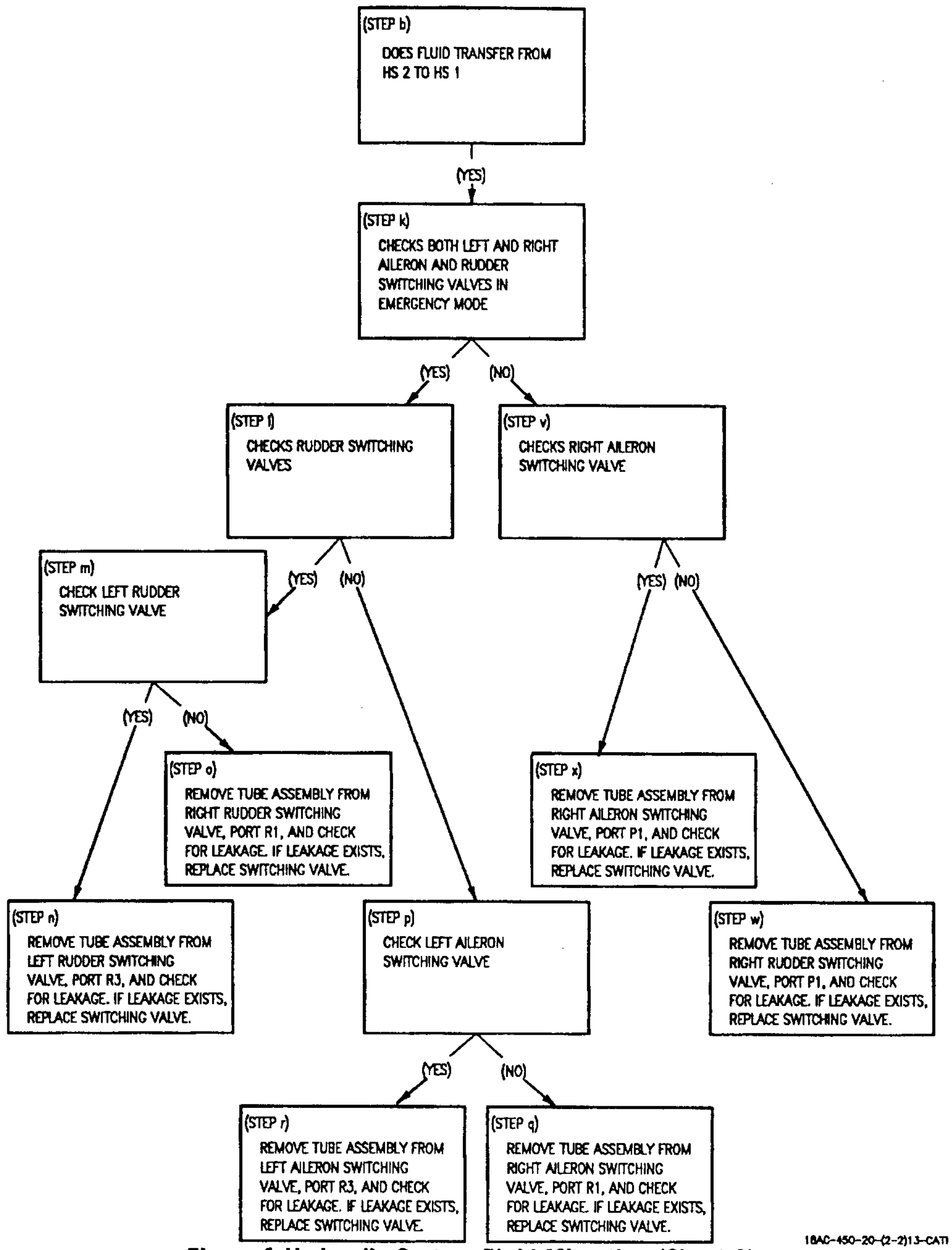

Figure 1.Hydraulic System Fluid Migration (Sheet 2)

Figure B1.0-41 A1-F18AC-450-200 3-00p79

Table 2. Pressure Temperature Test Set TTU-205 C/E Control Settings

Control	Setting
POWER switch	OFF
STATIC PRESSURE VENT	Full CW
PITOT PRESSURE VENT	Full CW
NORMAL/READ EXT switch	NORMAL
ALTITUDE RATE X 1000 FEET/MINUTE	5
ALTITUDE HOLD/NORM switch	NORMAL
ALTITUDE X 1000 FEET	0 SEA LEVEL
ALTITUDE TRIM	Centered
AIRSPEED RATE KNOTS/MINUTE	200
AIRSPEED KNOTS	150
AIRSPEED TRIM	Centered
LEAK TEST A/S switch	OFF
LEAK TEST ALT switch	OFF
MACH LIMIT SET	3.00
MACH LIMIT switch	NORMAL
MODULATION AMPLITUDE	0
MODULATION FREQUENCY HZ	OFF

Table 3. Altitude Scale Error Tolerances

Standard Altitude (Feet)	Tolerance (Feet)
0 (29.92 IN HG)	±40
5000	±50
10000	±90
15000	±110
20000	±140
25000	±165
30000	±195
35000	±215
40000	±240

1. **ILLUSTRATED PARTS BREAKDOWN.**

2. This illustrated parts breakdown has data required for identifying and ordering parts. The manual introduction has more information on IPB data.

Figure B1.0-42 A1-F18AC-510-200 3-01p14

INDEX NO.	NOMENCLATURE	REF DES
1	PITOT-STATIC PRESSURE ADAPTER SET IS MADE UP OF:	
2	STATIC HOSE ASSEMBLY	
3	PITOT HOSE ASSEMBLY	
4	PITOT FITTING	
5	SECURING NUT	
6	PITOT STATIC ADAPTER	
7	NOTCH	
8	STATIC FITTING	
9	STATIC PORT CLUSTER	
10	RIGHT L SHAPED PITOT STATIC TUBE	28HRB018
11	LEFT L SHAPED PITOT STATIC TUBE	28HRA017
12	TEST SET STATIC HOSE	
13	PRESSURE TEMPERATURE TEST SET TTU-205C/E	
14	POWER CABLE	
15	TEST SET PITOT HOSE	
16	UTILITY POWER ADAPTER	

Figure 1. Pitot Static System Test Equipment Hookup (Sheet 2)

Figure B1.0-43 A1-F18AC-510-200 3-010p16

Table 1. Pitot Static System and Related Instruments Leak and Functional Test

Procedure	Normal Indication	Remedy for Abnormal Indication

System Required Components

All system components installed.

Related Systems Required

Air Data Computer System
Electrical System
Flight Control System
Flight Incident Recorder and Monitoring System - F/A-18C and F/A-18D
Maintenance Status Display and Recording System - F/A-18A and F/A-18B
Mission Computer System

Support Equipment Required

Part Number or Type Designation	Nomenclature
18910010000	Pressure Temperature Test Set, TTU-205C/E
74D510001-1001	Pitot Static Pressure Adapter Set

Materials Required

None

NOTE

Component locations are shown in WP004 00.

Procedure	Normal Indication	Remedy for Abnormal Indication
1. TEST. (QA)		
a. Remove pitot-static probe aircraft ground servicing covers (A1-F18AC-PCM-000).		
b. Make sure L shaped pitot static tubes are free of obstructions.	No visible obstructions.	Remove obstructions as required.

Figure B1.0-44 A1-F18AC-510-200 3-01p2

Table 1. Pitot Static System and Related Instruments Leak and Functional Test (Continued)

Procedure	Normal Indication	Remedy for Abnormal Indication
ai. On test set (13), observe ALTITUDE FEET indicator.	Leak rate is less than 600 feet in 1 minute.	On test set (13), set ALTITUDE X 1000 FEET control to field elevation plus 5000 feet. Locate loose or damaged fitting or damaged line in static system (A1-F18AC-510-500, figure 5 or 6, WP003 00). After system is repaired, set ALTITUDE X 1000 FEET control to 40.
aj. On test set (13), set LEAK TEST ALT switch to OFF. Allow approximately 1 minute for STATIC PRESSURE READY light on test set (13) to come on.	1. LEAK TEST ALT light on test set goes off.	Make sure test set is good (NAVAIR 17-15CA-37).
	2. STATIC PRESSURE READY light on test set comes on.	Make sure test set is good (NAVAIR 17-15CA-37).
ak. On test set (13), set LEAK TEST A/S switch to ON. Allow AIRSPEED KNOTS indicator on test set to stabilize approximately 10 seconds.	1. LEAK TEST A/S light on test set comes on.	Make sure test set is good (NAVAIR 17-15CA-37).
	2. PITOT PRESSURE READY light on test set goes off.	Make sure test set is good (NAVAIR 17-15CA-37).
al. On test set (13), observe AIRSPEED KNOTS indicator.	Leak rate is less than 2 knots in 1 minute.	Locate loose or damaged fitting or damaged line system (A1-F18AC-510-500, figure 5 or 6, WP003 00).
am. On test set (13), set LEAK TEST A/S switch to OFF. Allow approximately 1 minute for PITOT PRESSURE READY light on test set to come on.	1. LEAK TEST A/S light on test set goes off.	Make sure test set is good (NAVAIR 17-15CA-37).
	2. PITOT PRESSURE READY light on test set comes on.	Make sure test set is good (NAVAIR 17-15CA-37).
an. On test set (13), set ALTITUDE X 1000 FEET control to field elevation and allow ALTITUDE FEET indicator to stabilize.		
ao. Observe Vertical Speed Indicator AVU-29/A or Vertical Speed Indicator AAU-53/A pointer (cockpit and rear cockpit).	Vertical Speed Indicator AVU-29/A or Vertical Speed Indicator AAU-53/A pointer indicates 0.	Lightly tap Vertical Speed Indicator AVU-29/A or Vertical Speed Indicator AAU-53/A. If pointer does not indicate 0, replace Vertical Speed Indicator AVU/29/A or Vertical Speed Indicator AAU-53/A (A1-F18AC-510-300, WP004 00).

Figure B1.0-45 A1-F18AC-510-200 3-00p8

Table 2. Memory Inspect 87X-034 (Continued)

Unit #7 Address	Data Item
	SERVO INHIBITING CONDITIONS
40032	DERO POT ANGLE vs DERO RESOLVER FAIL
40033	TWIST CAP POT ANGLE vs CALC TWIST CAP ANGLE FAIL
40034	TWIST CAP ANGLE > 190° FAIL
40035	DERO ERROR > 20° FOR 1 SECOND
40057	CRU WRAPAROUND FAIL WORD MSB 0 = +5 Vdc TRACKER POWER 1 = MOTOR POWER DISENGAGE 2 = PROTECTIVE SHUTDOWN 3 = OPERATE DISABLE 4 = FIFO READ ENABLE 5 = BIT AMP SELECT 6 = FLIR POLARITY 7 = FLIR FOV

Figure B1.0-46 A1-F18AC-744-210 4-00p10

	Nomenclature	Index No.	Ref Des
13	AIRCRAFT MAINTENANCE INDICATOR ID-2388/ ASQ-194	21A	85A-G003
	AIR DATA COMPUTER CP-1334/A	18	70A-F001
	AIR DATA SENSOR DT-600/ASW-44(BADSA)	22	84A-D012
	AVERAGE STATIC MOISTURE TRAP ASSEMBLY	40	28VAB506
8	AVERAGE STATIC TUBE TEE	8	28MPL509
	CONTROL-CONVERTER C-10382/A	17	82A-F001
	DIGITAL DATA COMPUTER NO. 1	28	83A-E001
12	DIGITAL DISPLAY INDICATOR ID-2150/ASM-612	21	85A-G003
	ECS PANEL ASSEMBLY	6	52A-J078
	GND PWR CONTROL PANEL ASSEMBLY	7	1A-H004
	HEAD-UP DISPLAY UNIT	3	79A-J001
17	INDICATED AIRSPEED INDICATOR AVU-30/A	3B	33M-J007
18	INDICATED AIRSPEED INDICATOR AVU-35/A	3B	33M-J007
	LANDING GEAR CONTROL UNIT	43	12A-D004 9 12A-A004 10
	LEFT CURRENT FLOW SENSOR	35	28A-B015
	LEFT DIGITAL DISPLAY INDICATOR	1	80A-H001
	LEFT SHAPED PITOT STATIC TUBE	30	28HRA017
	LEFT PITOT MOISTURE TRAP ASSEMBLY	42	28VAA504
	LEFT STATIC MOISTURE TRAP ASSEMBLY	41	28VAA505
	LH ADVISORY AND THREAT WARNING INDICATOR PANEL	2	52A-H073
	LIGHTNING ARRESTER	38	28E-A013
	LIGHTNING ARRESTER	39	28E-A021
	LIGHTNING ARRESTER	32	28E-B014
	LIGHTNING ARRESTER	33	28E-B022

Figure 1. Pitot Static System and Related Instruments Component Locator (Sheet 11)

Figure B1.0-47 A1-F18AC-510-200 4-00p12

	Nomenclature	Index No.	Ref Des
12	SIGNAL DATA RECORDER RO-508/ASM-612	19	85A-F001
17	STANDBY PRESSURE ALTIMETER AAU-39/A	4	33M-J002
18	STANDBY PRESSURE ALTIMETER AAU-52/A	4	33M-J002
	STATIC SOURCE SELECT VALVE	9	28VAJ502
	STATIC TUBE TEE	10	28MPJ501
17	VERTICAL SPEED INDICATOR AVU-29/A	5	33M-J008
18	VERTICAL SPEED INDICATOR AAU-53/A	5	33M-J008

1. AIRCRAFT CONNECTOR LOCATIONS ARE SHOWN IN A1-F18A( )WRM-000.
2. F/A-18B AND F/A-18D.
3. 161353 THRU 161359.
4. 161360 AND UP.
5. F/A-18A 161520 AND UP; ALSO F/A-18A 161353 THRU 161519 AFTER F/A-18 AFC 27; AND F/A-18C.
6. F/A-18B 161704 AND UP; AND F/A-18D.
7. F/A-18B 161354 THRU 161360.
8. 161520 AND UP; ALSO 161353 THRU 161519 AFTER F/A-18 AFC 27.
9. 161353 THRU 161987 BEFORE F/A-18 AFC 48.
10. 162394 AND UP; ALSO 161353 THRU 161987 AFTER F/A-18 AFC 48.
11. F/A-18B 161704 AND UP; ALSO F/A-18B 161354 THRU 161360 AFTER F/A-18 AFC 27; AND F/A-18D.
12. F/A-18A AND F/A-18B.
13. F/A-18C AND F/A-18D.
14. DOOR LOCATIONS ARE SHOWN IN A1-F18AC-LMM-010.
15. F/A-18B AND F/A-18D 163434 THRU 163778
16. F/A-18D 163986 AND UP
17. 161353 THRU 163782.
18. 163985 AND UP.
19. F/A-18B AND F/A-18D 161354 THRU 163778.

Figure 1. Pitot Static System and Related Instruments Component Locator (Sheet 13)

Figure B1.0-48 A1-F18AC-510-200 4-00p14

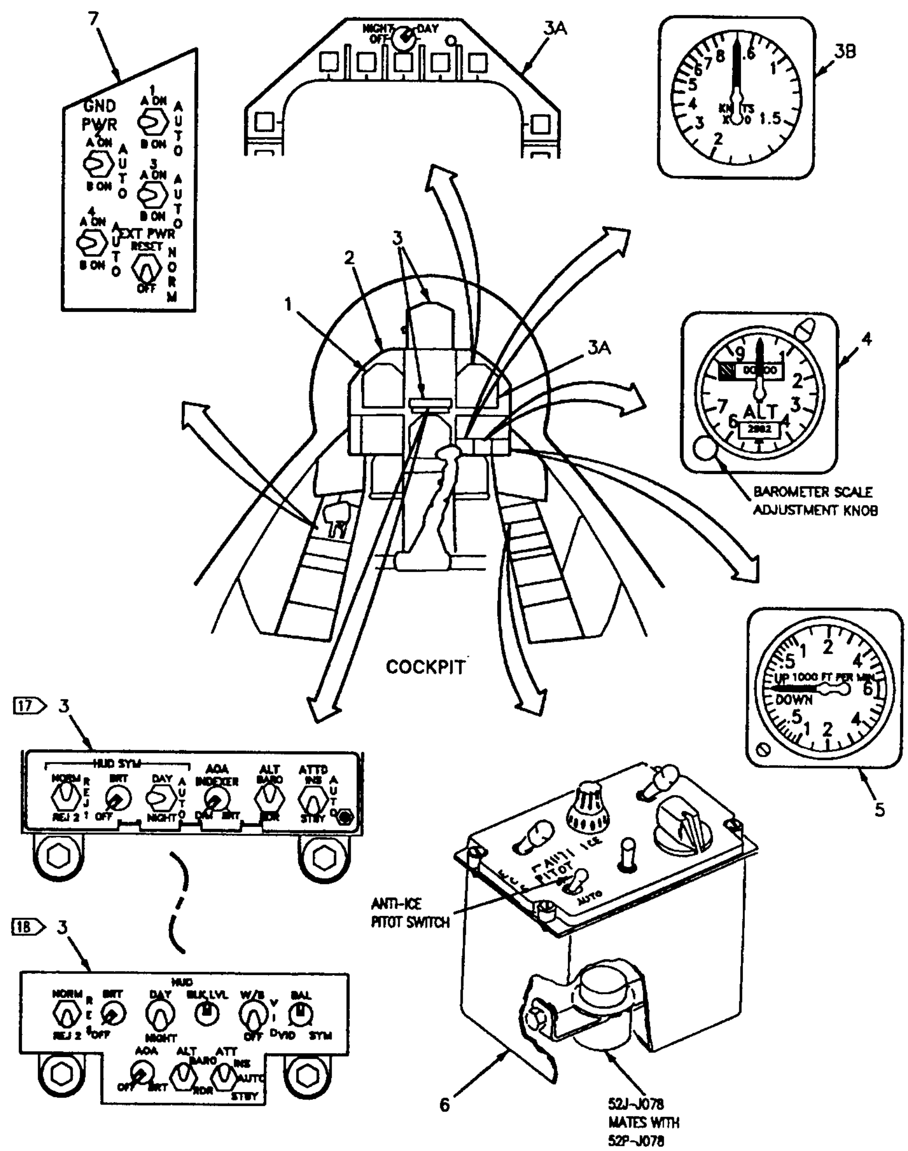

Figure 1. Pitot Static System and Related Instruments Component Locator (Sheet 1)

Figure B1.0-49 A1-F18AC-510-200 4-00p2

A1-F18AC-744-210

004 00

Page 2

Table 1. FLIR BIT Matrix 87X-034

MESSAGE	WORD OCTAL	BIT NUMBER (CALLED WITH GRAY SCALE)							
		0	1	2	3	4	5	6	7
31	3 61742	IBIT IN TEST**	FLIR NO-GO	IBIT DONE**	FLIR FAIL	AUTOTRACK FUNCT	SIGHTLINE FUNCT	ENVIRON- MENTAL FUNCT	DEGRAD PERFOR- MANCE
18	1 61100	RIR DEROTATION DC $ FLF	DEROTATION P.S. DC $ MPF	BORESIGHT CNST A IB $ BAF	BORESIGHT CNST B IB $ BBF	BORESIGHT CNST C IB $ BCF	IBIT IN TEST** IB $ BIP	BORESIGHT SOURCE IB $ BSS	0
	2 61101	TEMP SENSOR B IC $ TBF	TEMP SENSOR C IC $ TCF	TEMP SENSOR D IC $ TDF	TEMP SENSOR E IC $ TEF	TEMP> LIMIT** IC $ TOL	ANGLE CONV (CCM) PA $ ACF	-5V* SW BOARD PA $ ANS	+5V* SW BOARD PA $ APS
	3 61102	PITCH CHAN PA $ FPC	ROLL CHAN PA $ FRC	YAW CHAN PA $ FYC	HEAD DISABLED** PA $ HDS	INT RATES EXCD** PA $ IRF	INT VEL EXCD** PA $ IVF	MUX PA $ MFF	MOTOR* POWER DISENG** PA $ MPD
	4 61103	+10V* PREAMP PA $ P06	-9V* POSTAMP PA $ PO7	+5V COMP (1) PA $ P08	-15V SERVO PA $ P09	+50V ROLL PA $ P10	+50V DERO PA $ P11	-8.5V CAMERA PA $ P12	+5V* SCAN PA $ P13
	5 61104	+15V* SCAN PA $ P22	+10V* LED PA $ P23	+5V SERVO PA $ P24	+15V SERVO PA $ P25	+28V STDBY SWITCH PA $ P26	+50V* INNER GIMBAL PA $ P27	-5V SERVO PA $ P28	+8.5V* CAMERA PA $ P29
	6 61105	P AMP * REG BIT 2 PA $ PR2	P AMP* REG BIT 3 PA $ PR3	P AMP* REG BIT 4 PA $ PR4	P AMP* REG BIT 5 PA $ PR5	P AMP* REG BIT 6 PA $ PR6	P AMP* REG BIT 7 PA $ PR7	P AMP* REG BIT 8 PA $ PR8	P AMP* REG BIT 9 PA $ PR9
	7 61106	OS WRA PA $ S20	RDA WRA PA $ S22	RDM WRA PA $ S23	SIGHTLN FUNCT PA $ S24	SC WRA PA $ S26	PFS WRA PA $ S27	TC WRA PA $ S28	PAS WRA PA $ S29

*Flag Set Durine STANDBY; **Status only; not a fail flag.

Figure B1.0-50 A1-F18AC-744-210 4-00p2

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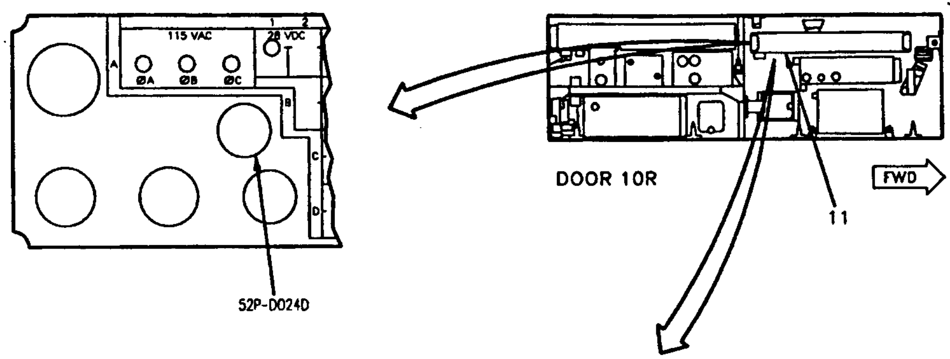
Page 3

Table 1. FLIR BIT Matrix 87X-034 (Continued)

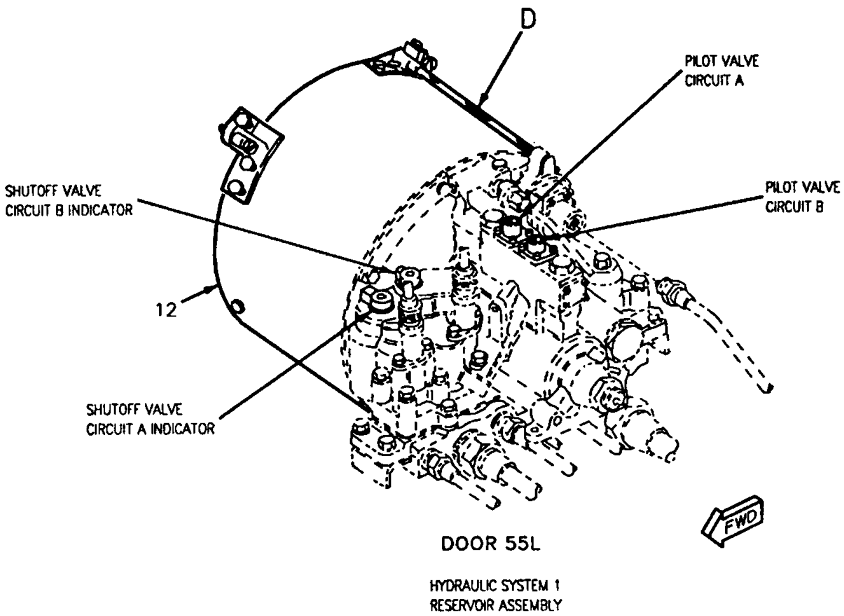
MESSAGE	WORD OCTAL	BIT NUMBER (CALLED WITH GRAY SCALE)							
		8	9	10	11	12	13	14	15
31	3 61742	BORESIGHT FAIL	0	0	0	0	0	0	POD OVER- HEAT**
18	1 61100	0	0	LEVEL IB $ LVT	SERVO CNTL IB $ SCW	IBIT TRKR IB $ TKF	FOCUS IC $ FCF	FOV SWITCH IC $ IFF	TEMP SENSOR A IC $ TAF
	2 61101	ANGULAR RATE FAIL PA $ ARF	BIAS* REG BIT PA $ BR	BIT STATUS INHIB** PA $ BSI	CAMERA BIT PA $ CBT	COOLDOWN FAIL PA $ CDF	CP INTERRUPT PA $ CIF	DEFAULT FAIL PA $ DFF	DERO CHAN PA $ FDC
	3 61102	PROC (A) PA $ MPF	OPER* P.S. DISABLE** PA $ OPD	OPER P.S. SWITCH PA $ OSM	-15V IRIS PA $ P01	-28V SERVO PA $ P02	+50V* OUTER GIMBAL PA $ P03	+5V COMP (2) PA $ P04	+15V* SCAN PA $ P05
	4 61103	+10V POSTAMP PA $ P14	+28V* DERO BRAKE PA $ P15	+5V COMP (3) PA $ P16	-6V* TRACKER PA $ P17	+15V IRIS PA $ P18	+28V SERVO PA $ P19	-5V* SCAN PA $ P20	+50V* WIND- SCREEN PA $ P21
	5 61104	+40V* CAMERA PA $ P30	-5V COMPUTER PA $ P32	+19V FOCUS PA $ P33	-19V FOCUS PA $ P34	+15V SBI PA $ P35	-15V SBI PA $ P38	PROM (A) FAIL PA $ PFF	P AMP* REG BIT 1 PA $ PR1
	6 61105	0	RAM (A) PA $ RFF	POWER SUP- PLY RIPPLE PA $ RPF	RECEIVER STOW PA $ RSF	UNDERCOOL WARNING** PA $ S09	OVERCOOL WARNING** PA $ S10	FAN #3 PA $ S12	AUTOCOL- LIMATOR PA $ S13
	7 61106	FAN #1 PA $ S30	FAN #2 PA $ S31	SCANNER BIT PA $ SBT	STAB READY PA $ SFF	SC INTERRUPT PA $ SIF	STOW PA $ STF	0	A/D WRAP PA $ WAD

*Flag Set During STANDBY; **Status only; not a fail flag.

Figure B1.0-51 A1-F18AC744-210 4-00p3



52A-D024	NO. 2 CIRCUIT BREAKER PANEL ASSEMBLY		
ZONE	REF DES	NOMENCLATURE	BUS
A17	10CBD001	HYD SYS NO. 1	R 26VAC ϕ C
A18	10CBD002	HYD SYS NO. 2	R 26VAC ϕ C



1BAC-450-20-(1-3)14-SCAN

Figure 1. Hydraulic System Component Locator (Sheet 3)

Figure B1.0-52 A1-F18AC-450-200 4-00p4

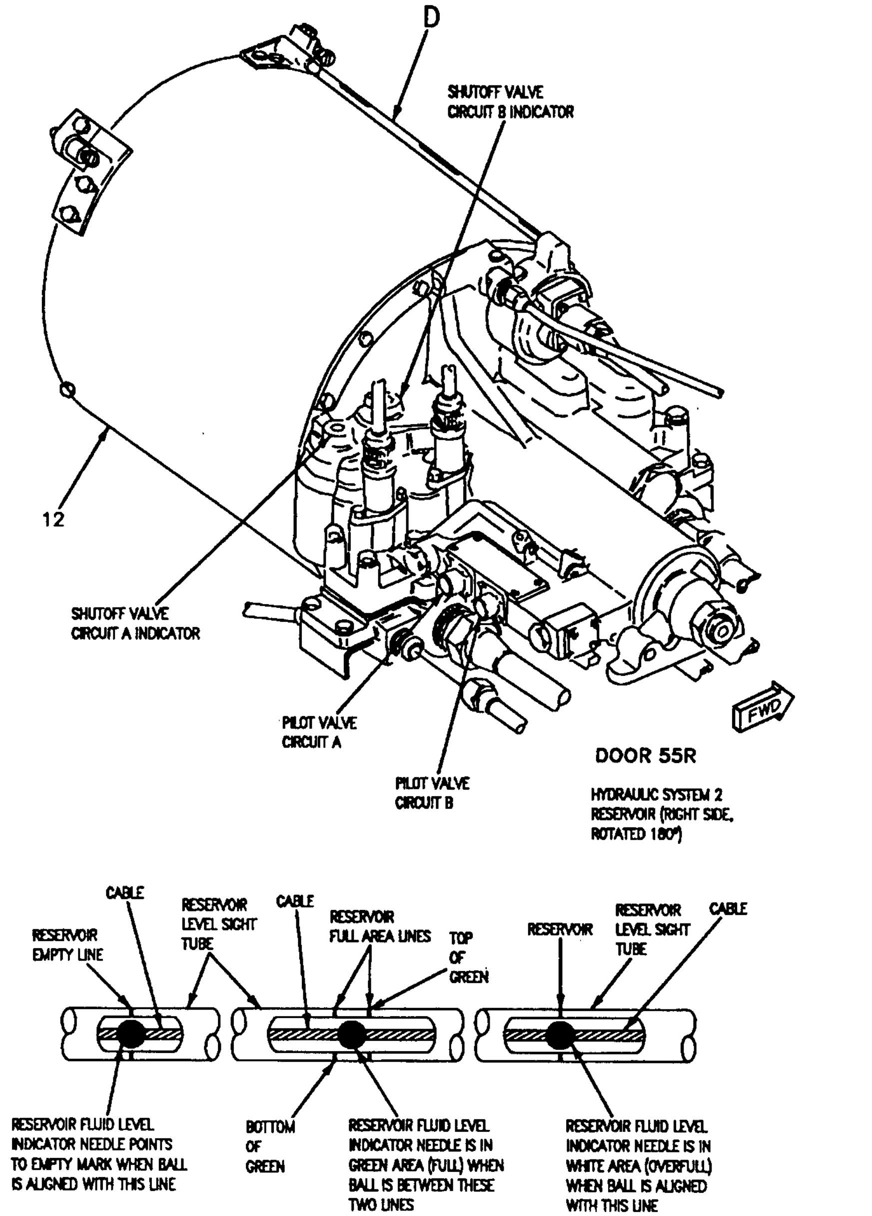


Figure 1. Hydraulic System Component Locator (Sheet 4)

Figure B1.0-53 A1-F18AC-450-200 4-00p5

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Table 2. Memory Inspect 87X-034 (Continued)

Unit #7 Address	Data Item	Unit #7 Address	Data Item
	POWER SUPPLY FAILS		POWER SUPPLY FAILS
41040	1. -15 V IRIS	41057	16. +5 V COMPUTER (3)
41041	2. -28 V SERVO	41060	17. -6 V TRACKER
41042	3. +50 V OUTER GIMBAL	41061	18. +15 V IRIS
41043	4. +5 V COMPUTER (2)	41062	19. +28 V SERVO
41044	5. -15 V SCAN	41063	20. -5 V SCAN
41045	6. +10 V PREAMP	41064	21. +50 V WINDSCREEN
41046	7. -9 V POSTAMP	41065	22. +15 V SCAN
41047	8. +5 V COMPUTER (1)	41066	23. +10 V LED
41050	9. -15 V SERVO	41067	24. +5 V SERVO
41051	10. +50 V ROLL	41070	25. +15 V SERVO
41052	11. +50 V DERO	41071	26. +28 V STANDBY SWITCH
41053	12. -8.5 V CAMERA	41072	27. +50 V INNER GIMBAL
41054	13. +5 V SCAN	41073	28. -5 V SERVO
41055	14. +10 V POST AMP	41074	29. +8.5 V CAMERA
41056	15. +28 V DEROTATION BRAKE		

Figure B1.0-54 A1-F18AC-744-210 4-00p7

A1-F18AC-744-210

004 00

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Table 2. Memory Inspect 87X-034 (Continued)

Unit #7 Address	Data Item	Unit #7 Address	Data Item
	POWER SUPPLY FAILS		FAIL/STATUS FLAGS
41100	+40 V CAMERA	40020	RECEIVER STOWED
41101	(NOT USED)	40021	DEROTATION FAIL
41102	-5 V COMPUTER	40022	MOTOR POWER FAIL
41103	+19 V FOCUS	40043	SERVO CONTROLLER FAIL
41104	-19 V FOCUS	40050	BORESIGHT SOURCE FAIL
41105	+15 V SBI	40051	TRACKER FAIL
41106	-15 V SBI		
		40565	EPROM "A" FAIL
	FAIL/STATUS FLAGS	40567	PITCH CHANNEL FAIL
		40570	ROLL CHANNEL FAIL
40000	FLIR COOLDOWN COMPLETE	40571	YAW CHANNEL FAIL
40001	BORESIGHT ENABLE	40572	DEROTATION FAIL
40002	SC TRANSMIT FAIL	40574	CCM FAIL
40003	CP TRANSMIT FAIL	40541	"A" RAM FAIL
40004	FIFO FAIL		
40006	FOV FAIL	40673	PROCESSOR "A" FAIL
40007	FOV INHIBIT		
40010	FOCUS FAIL	40726	MUX "A" FAIL
40011	TEMPERATURE OUT OF LIMIT		

Figure B1.0-55 A1-F18AC-744-210 4-00p8

Nomenclature	Index No.	Ref Des
AIRCRAFT CONTROLLER GRIP ASSEMBLY	10	52A-J501
CASE DRAIN FILTER (HS1)	15	10U-P513
CASE DRAIN FILTER (HS2)		10U-R514
FCS CONTROL PANEL C-10406/ASW-44 RESET SWITCH	7	84A-H003
FLUID LEVEL INDICATOR AND FLEXIBLE CABLE (HS1)	17	10M-P010
FLUID LEVEL INDICATOR AND FLEXIBLE CABLE (HS2)		10M-P011
GROUND POWER CONTROL PANEL ASSEMBLY 4 SWITCH	8	1A-H004 1S-H051
FILTER UNIT (HS1)	13	10U-P507
FILTER UNIT (HS2)		10U-R508
FUEL SYSTEM CONTROL PANEL PROBE CONTROL SWITCH	6	5A-H027 5S-H005
HEAD-UP DISPLAY UNIT AN/AVQ-28	9	79A-J001
1 HORIZONTAL INDICATOR IP-1350/A	3	80A-J003
HYDRAULIC PRESSURE INDICATOR AGU-15/A (FRONT)	19	10M-J005
HYDRAULIC PRESSURE INDICATOR AGU-15/A (REAR)		10M-L018
HYDRAULIC PRESSURE TRANSMITTER (HS1)	16	10HPP003
HYDRAULIC PRESSURE TRANSMITTER (HS2)		10HPR004
1 LEFT DIGITAL DISPLAY INDICATOR IP-1317( ) (DDI)	1	80A-H001
LH VERTICAL CONSOLE CONTROL PANEL ASSEMBLY FLAP SWITCH	4	52A-H077 84S-H039
NO. 2 CIRCUIT BREAKER PANEL ASSEMBLY	11	52A-D024
QUADRANT ASSEMBLY-POWER CONTROL SPEED BRAKE SWITCH	5	52A-H088 18S-H002

Figure 1. Hydraulic System Component Locator (Sheet 8)

Figure B1.0-56 A1-F18AC-450-200 4-00p9

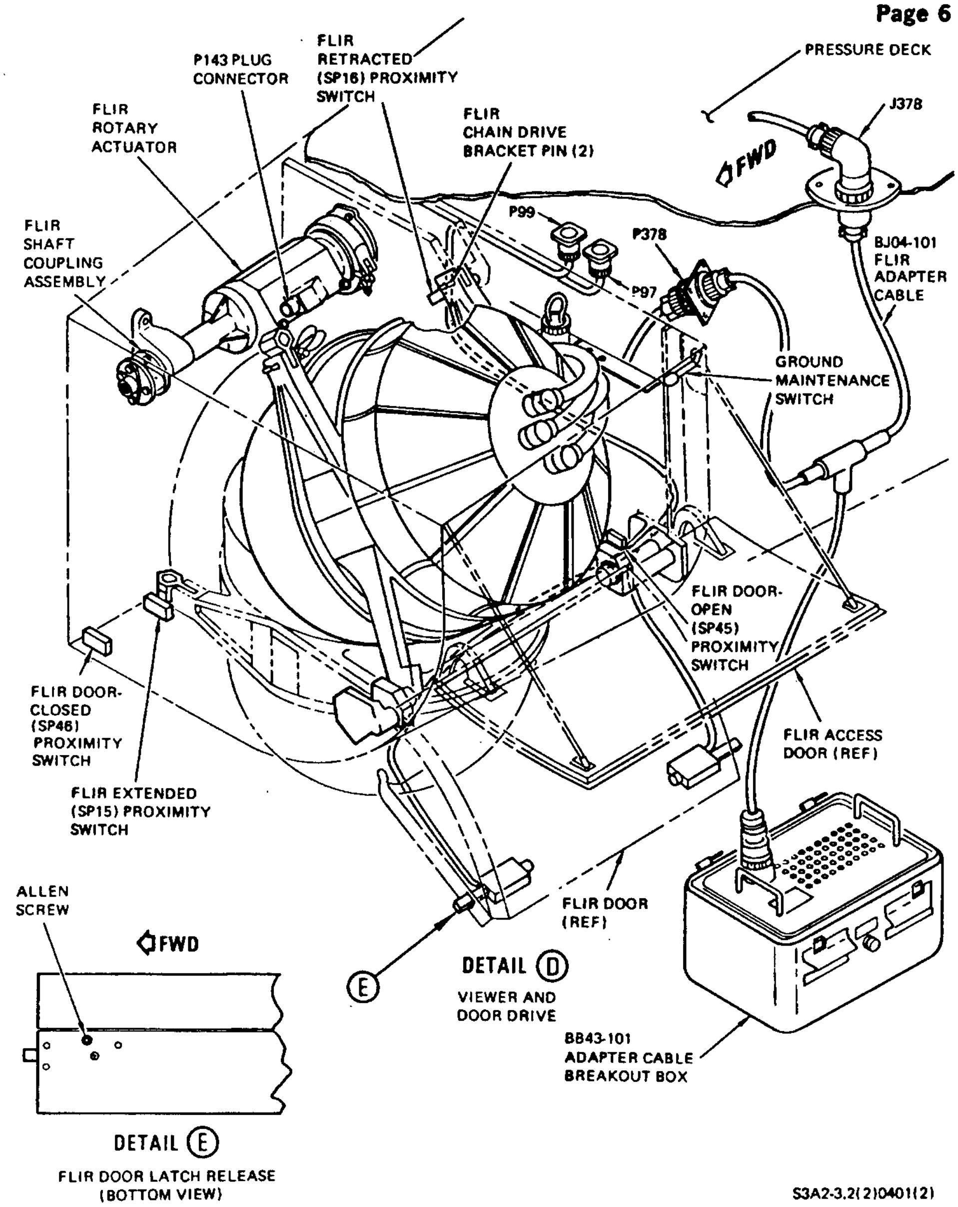
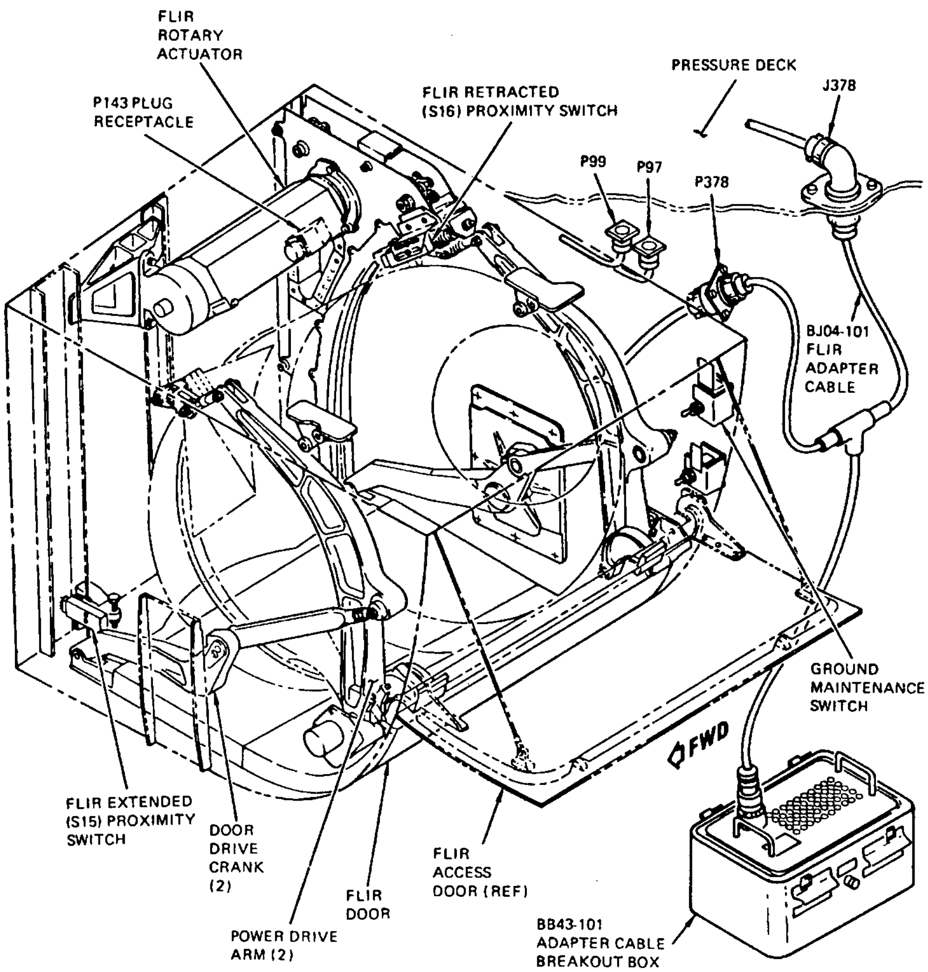


Figure 1. Infrared Viewer and Door Cable Drive System Controls and Components Location Diagram (Sheet 2)

Figure B1.0-57 NAVAIR 01-S3AAA-2-3.2 4-01p6



DETAIL (D)

VIEWER AND DOOR DRIVE

S3A2-3.2(1)0403(2)

Figure 1. Infrared Viewer and Door Crank Drive Mechanism System Controls and Components Location Diagram (Sheet 2)

Figure B1.0-58 NAVAIR 01-S3AAA-2-3.2 4-02p6

TABLE 4. L CLA INPUT/OUTPUT SIGNALS (CONT)

Pin Identification			
P464	**P378**	**L CLA Inputs**	**BB43-101 Adapter Cable Breakout Box Test Point**
73	U	32M - Torque limiter, shaft A, CCW - SP48	J19
74	T	33M - Torque limiter, shaft B, CW - SP49	J20
75	S	34M - Torque limiter, shaft B, CCW - SP50	J21
68		39M - Turrent in position for retraction	
69		40M - FLIR control signal-extend	
70		41M - FLIR emergency retract switch - retract	
71		42M - FLIR control signal - retract	
		$\overline{17GO}$ - Weight not on both main landing gear	
P444	**P228**	**L CLA Outputs**	
50	65	11MO - FLIR extend verify	optical isolation
52	66	12MO - FLIR retract verify	optical isolation
P444	**P768**		
54	54	16MO - FLIR rotary actuator energized (CW for $\overline{17MO}$)	
55	55	17MO - FLIR rotary actuator energized CCW	
58	58	22MO - Control, shaft B, CW (lower FLIR)	
59	59	23MO - Control, shaft B, CCW (raise FLIR)	

Figure B1.0-59 NAVAIR 01-S3AAA-2-3.2 4-02p9

Table 2. Left L Shaped Pitot Static Tube Hot With Weight On Wheels or Simulated Weight On Wheels and ANTI ICE PITOT Switch in AUTO (Continued)

Procedure	No	Yes
(2) Disconnect 52P-C057E from no. 7 circuit breaker/relay panel assembly (door 10L) (A1-F18AC-LMM-010).		
(3) Turn on electrical power (A1-F18AC-LMM-000). Does 28vdc exist at 52P-C057E pin 45?	c	b
b. Turn off electrical power (A1-F18AC-LMM-000). Isolate between no. 7 circuit breaker/relay panel assembly wiring and 28K-C009 relay (A1-F18AC-420-300, WP027 00) and do step h.	-	-
c. Do the substeps below:		
(1) Turn off electrical power (A1-F18AC-LMM-000).		
(2) Disconnect 52P-E059 from no. 3 relay panel assembly (door 13L) (A1-F18AC-LMM-010).		
(3) Turn on electrical power (A1-F18AC-LMM-000). Does 28vdc exist at 52P-E059 pin 67?	d	e
d. Turn off electrical power (A1-F18AC-LMM-000). Isolate defective aircraft wiring between 52P-E059 pin 67 and 52P-F058B pin 25 (A1-F18A( )-WDM-000) and do step h.	-	-
e. Do the substeps below:		
(1) Turn off electrical power (A1-F18AC-LMM-000).		
(2) Does continuity exist between 52P-C057E pin 45 and 52P-E059 pin 88?	f	g
f. Isolate defective aircraft wiring between 52P-C057E pin 45 and 52P-E059 pin 88 (A1-F18A( )-WDM-000) and do step h.	-	-
g. Isolate between no. 3 relay panel assembly wiring and 12K-E020 relay (A1-F18AC-420-300, WP035 00) and do step h.	-	-
h. If disconnected, removed, or opened during this procedure, make sure the items listed below are connected, installed, or closed:		
(1) 52P-C057E		
(2) 52P-E059		
(3) Door 10L (A1-F18AC-LMM-010)		
(4) Door 13L (A1-F18AC-LMM-010)	-	-

Figure B1.0-60 A1-F18AC-510-200 5-00p6

A1-F18AC-744-210 **005 00**

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Table 2. Memory Inspect Matrix Data 89X-035 and 91X+038 (Continued)

	OCTAL ADDRS	BIT 0	BIT 1	BIT 2	BIT 3	BIT 4	BIT 5	BIT 6	BIT 7
10	54411								← LASER → CODE ECHO
11	54412						← LASER RANGE →		
12	54413							← RANGE STALENESS →	
13	54414								
14	54415								
15	54416								
16	54417								
17	54420								
18	54421								

ACCUMULATOR FLAGS		
7	54346	LASER BOT MISSING COUNT
8	54347	SC EOT FAIL
9	54350	IBIT LPS FAIL
10	54351	IBIT LASER TRANSMIT FAIL
11	54352	LTR FAIL
12	54353	LTD/R OVERTEMP
13	54354	LTD/R LOW POWER
14	54355	LTD/R RANGE FUNCTION FAIL
15	54356	LTD/R TRANSMIT FUNCTION FAIL
16	54357	LPS FAIL

OPERATING STATE VALUES:	
0	STANDBY
1	STBY ARM ENABLE
2	READY
3	FIRING
4	IBIT STBY
5	IBIT STBY A.E.
6	IBIT READY
7	IBIT FIRING
8-15	NOT VALID

Figure B1.0-60 A1-F18AC-744-210 5-00p7

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Table 2. Memory Inspect Matrix Data 89X-035 and 91X+038 (Continued)

	OCTAL ADDRS	BIT 8	BIT 9	BIT 10	BIT 11	BIT 12	BIT 13	BIT 14	BIT 15
1	54400	LTD/R MSG 50 ms	SERVO INHIBIT	SC FAIL		← FLIR STATUS →			
2	54401						OPERATE ARM ENABLE	OPERATE ARM ON	
3	54402	LAST LTD/R MSG VALID	ALT LASER FIRE	UNWIND COMPLETE	TRANSMIT BLOCKED	LTD/R OPERATE	READY FIRE 0.5 s DELAY		
4	54403		HIGH ALT INHIBIT	IBIT CMD		OPERATE	OPER ARM ENABLE	IBIT ARM ENABLE	FIRE
5	54404	← LASER CODE →							
6	54405						NUMBER OF WORDS OF MEMORY INSPECT		
7	54406	← MEMORY INSPECT START ADDRESS →							
8	54407	LPS FAIL	CHECKSUM FAIL	IBIT ACK		IBIT COMPLETE	FIRE ACK	OPERATE ARM ON	IBIT ARM ON
9	54410	INVALID CMD	TRANSMIT FUNC FAIL	RANGE FUNC FAIL	TRANSMIT BLOCKED	LOW POWER	OVER TEMP		LTR FAIL

Figure B1.0-61 A1-F18AC-744-210 5-00p8

Table 3. R PITOT HT Caution Light ON and Code 835 Appears on Digital Display Indicator (Continued)

Procedure	No	Yes
(1) Turn off electrical power (A1-F18AC-LMM-000).		
(2) Open door 10R (A1-F18AC-LMM-010).		
(3) Disconnect 52P-D024C from no. 2 circuit breaker panel assembly.		
Does continuity exist between 52P-D024C pin D and 52P-F058A pin A?	d	s
n. Do the substeps below:		
(1) Turn off electrical power (A1-F18AC-LMM-000).		
(2) Disconnect 52P-F058B from no. 2 relay panel assembly.		
(3) Turn on electrical power (A1-F18AC-LMM-000).		
(4) On ECS panel assembly, set ANTI ICE PITOT switch to ON.		
Does 28vdc exist at $\boxed{1}$ 52P-F058B pin 1, $\boxed{2}$ 52P-F058C pin 71?	o	q
o. Do the substeps below:		
(1) Turn off electrical power (A1-F18AC-LMM-000).		
(2) $\boxed{1}$ Open door 10R (A1-F18AC-LMM-010).		
(3) $\boxed{2}$ Open door 6 (A1-F18AC-LMM-010).		
(4) Disconnect $\boxed{1}$ 12P-D004A, $\boxed{2}$ 12P-A004A from landing gear control unit.		
Does continuity exist from:		
$\boxed{1}$ 52P-F058B pin 1, $\boxed{2}$ 52P-F058C pin 71 to $\boxed{1}$ 12P-D004A, $\boxed{2}$ 12P-A004A pin 102?	p	r
p. Isolate defective wiring between 52P-F058B pin 1 and $\boxed{1}$ 12P-D004A, $\boxed{2}$ 12P-A004A pin 102 (A1-F18A( )-WDM-000) and do step t	-	-
q. Turn off electrical power (A1-F18AC-LMM-000). Replace relay 28K-F010 or 12K-F015 or isolate between no. 2 relay panel assembly wiring and 28K-F010, 12K-F015 relays (A1-F18AC-420-300, WP032 00) and do step t	-	-
r. Replace landing gear control unit (A1-F18AC-130-300, WP003 00) and do step t	-	-
s. Repair no. 2 circuit breaker panel assembly (A1-F18AC-420-300, WP024 00) and do step t	-	-
t. If disconnected, interchanged, removed, or opened during this procedure, make sure the items listed below are properly reconnected, installed, or closed:		

Figure B1.0-62 A1-F18AC-510-200 6-00p14

Table 4. Derotation Fail (Continued)

Step	Procedure	No	Yes
1	Using unit address 07, memory inspect the following addresses to determine which Derotation Fail data codes are set.		
	These words are true if the memory inspect response is a non-zero value (000001 or 177777). -38 Pods 87X-034; -38A Pods 89X-035 91X+038		
	Word / *Description* / *Address* / *Address*		
	DC$FF1 (Dero Pot Angle vs Dero Resolver Angle) 40032 54032	-	2
	DC$FF2 (Twistcap Pot Angle vs Calculated Twistcap Angle) 40033 54033	-	12
	DC$FF3 (Twistcap Angle >190 Degrees) 40034 54034	-	24
	DC$FF4 (Dero Error >20 Degrees for 1 second or more) 40035 54035	-	31
	For -38B pods these are bits located in one memory inspect word. This is Msg 17/Wd 3. The memory inspect address for this word is 165636004. These bits are true if set to 1.		
	BIT No.		
	2 DC$FF1 (Derotation Misalignment)	-	2
	4 DC$FF2 (Twistcap Misalignment)	-	12
	5 DC$FF3 (Twistcap Overlimit)	-	24
	8 DC$FF4 (Derotation Lag)	-	31

Figure B1.0-63 A1-F18AC-744-210 7-00p25

Table 6. Cooldown Fail (Continued)

Step	Procedure	No	Yes
4	Memory Inspect Unit 7 for the following addresses:		
	Software / Addresses / Msg / Word / Bit / Value		
	87X-034 and / 61102 / 18 / 3 / 3 / 0	7	5
	89X-035, 91X+038 / 61102 / 18 / 3 / 2 / 0	7	5
	09X-All / 165636104 / 18 / 3 / 2 / 0	7	5
	(Checking status of the "Head Disable" bit (PA$HDS), 1=Head Disabled)		
5	Memory Inspect Unit 7 for the following addresses:		
	Software / Addresses / Msg / Word / Bit / Value		
	87X-034 / 61111 / 18 / 10 / 0 / 1	9	6
	89X-035, 91X+038 / 61111 / 18 / 10 / 0 / 1	9	6
	09X-All / 165636122 / 18 / 10 / 0 / 1	9	6
	(Checking status of the "Stab Ready" bit (Gyro Spin-up Complete), 1=Stab Ready. Stab Ready is normally set to 1 within 30 seconds of Pod power up except in extremely cold environments.)		

Figure B1.0-64 A1-F18AC-744-210 7-00p53

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Table 1. Interchangeability Matrix (Continued)

WRA	Part No. (Pod Config.)	Interchangeable with -38	-38A	-38B
OS Group	242382/242547 (-38)	-	-38 Capability	-38 Capability
	260256/260488 (-38A)[1]	Yes[2]	-	-38A Capability
	260580/260581 (-38B)[1]	Yes[2]	-38A Capability	-
PAS	242576 (-38)	-	-38 Capability	-38 Capability
	260256, 260256-2 (-38A)[3]	-38 Capability	-	-38A Capability
	260583 (-38B)[3]	-38 Capability	-38A Capability	-
PFS	242547 (-38)	-	No	No
	260488/260344 (-38A)	No	-	-38A Capability
	260581 (-38B)	No	-38A Capability	-

NOTES: [1] LTR or surrogate must be installed.
[2] A -2 CP must be installed.
[3] LPS or surrogate must be installed.

Figure B1.0-65 A1-F18AC-744-210 8-00p3

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ORGANIZATIONAL MAINTENANCE
TESTING AND TROUBLESHOOTING

ALPHABETICAL INDEX

FORWARD LOOKING INFRARED SYSTEM
AN/AAS-38, AN/AAS-38A, AND AN/AAS-38B

Figure B1.0-66 A1-F18AC-744-210 1-00p1